

Lake Management Plan  
for  
Sugar Lake

Wright County, Minnesota

Revised: January 31, 2005

Healthy Lakes & Rivers Partnership Committee  
Sugar Lake Association

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## **Introduction**

In February and March 2003 the Sugar Lake Association was invited to participate in the Initiative Foundation's Healthy Lakes and Rivers Partnership program along with seven other Lake Associations in Wright County. Under the coordination of Brad Wozney (Wright County Water Planner) representatives of each group attended two days of training on strategic planning, communication, and nonprofit group leadership.

Representatives of many state and local agencies, as well as nonprofit organizations also attended the training sessions in order to offer their assistance to each group in developing a strategic Lake Management Plan. The Crow Wing Headwaters Association was represented at the Healthy Lakes & Rivers training sessions by: Dale Gustafson, Andy Juetten, Clifford Mol Don Peterson, Robert Stockstead, and Mike Zieska.

Following the training sessions, each Lake Association held an inclusive community planning/visioning session designed to identify key community concerns, assets, opportunities, and priorities. The Sugar Lake Association held this planning session on June 14, 2003, facilitated by Doug Malchow. Details of the public input received at this session are provided within this plan.

This document is intended to create a record of historic and existing conditions and influences on Sugar Lake, and to identify the goals of the Sugar Lake community. Ultimately it is meant to also help prioritize goals, and guide citizen action and engagement in the priority action areas. Clearly state agencies and local units of government also have a vital role and responsibility in managing our surface waters and other natural resources, but above all else this Lake Management Plan is intended to be an assessment of what we as citizens can influence, what our desired outcomes are, and how we will participate in shaping our own destiny.

This Lake Management Plan is also intended to be a "living document;" as new or better information becomes available, as we accomplish our goals or discovered that alternative strategies are needed it is our intent to update this plan so that it continues to serve as a useful guide to future leaders.

In discussing lake management issues, it is impossible to avoid all scientific or technical terms. We have tried to express our goals, measures of success, and other themes as simply and clearly as possible, but have included a glossary of common limnological terms at the end of the plan to assist the reader. Limnology is the state of lake conditions and behavior.

Finally, we would like to thank the funders of the Healthy Lakes & Rivers Partnership program for Wright County, including The McKnight Foundation, Laura Jane Musser Trust, Wright-Hennepin Electrical Cooperative, Wright County Soil & Water Conservation District, Minnesota Board of Water & Soil Resources, Dr. John & Janet Moran, Wright County Federated Sportsman's Club, Lake Hubert Association -- Crow Wing County, Linda Kaufmann and Don Hickman & Sandra Kaplan. Additional support has recently been provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative Commission on Natural Resources (LCMR).

## **Physical Characteristics and location of Sugar Lake**

Sugar Lake (DNR ID# 86-0233) is located two miles northwest of the City of Silver Lake. The lake has a surface area of 1,015 acres, of which 357 acres (35 percent) is in the littoral zone (the area where depth is 15 feet or less). Water clarity averages around 8 feet. Sugar Lake is in the upper five percent of lakes in the state in terms of size, and has a maximum depth of 62 feet, and a mean depth of 24 feet. The lake has twenty-two inlets (one natural, twenty-one culverts) and one outlet. Sugar Lake has a watershed of approximately 5.6 square miles and a watershed to lake ratio of 4:1.

In 1999 the Minnesota Pollution Control Agency (MPCA) completed a Lake Assessment Program (LAP) analysis of Sugar Lake which summarizes the water quality, land use, and other characteristics and influences. This report was a vital source of information for this Lake Management Plan (Appendix 1).

### Precipitation

In 1996 the Minnesota Pollution Control Agency (MPCA) completed a Lake Assessment Program (LAP) evaluation of nearby Ann Lake. The following characterization of precipitation was offered in this report:

Based on State Climatology records, precipitation averaged 28-30 inches (0.72-0.76 m) annually in this part of the state with about 18-19 inches of that amount in May through September.

Evaporation typically exceeds precipitation in this part of the state and averages about 36 inches (0.91 m) per year. Runoff averages about 5 inches with 1-in-10 year low and high values (low and high runoff values which might occur with a frequency of once in ten years) of 1 inch and 8.0 inches, respectively for this area (Gunard, 1985).

### Soils

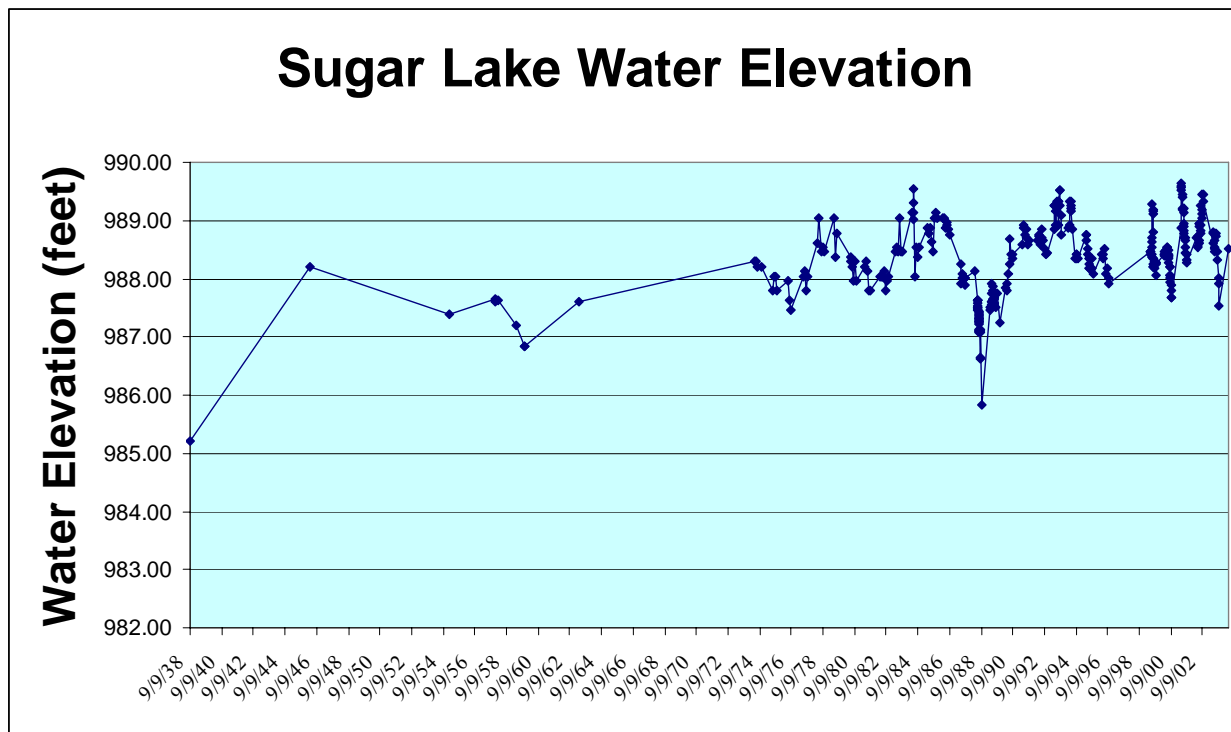
The 1999 MPCA LAP Study provides the following summary:

Sugar Lake is an ice-block basin formed partially in end moraine glacial till and partially in frontal glacial outwash plains deposits of the Des Moines Lobe, the most recent glacial lobe (Goebel and Walton, 1979 and Zumberve, 1952). Soils near the lake tend to be coarse to fine textured forest soils and are from the Hayden series soils (Arneman, 1963). This area has gentle to strong rolling hills. These soils tend to be well drained with major erosion control problems. The light colored soils are formed from calcareous loam or clay loam glacial till. Poorly drained depressions in the area are often occupied by dark colored Bluffton soils or peat and muck (Arneman, 1963).

Water Level

The DNR Division of Waters, with the cooperation of volunteer readers, has monitored water level since 1938. Jim Kastl of the Sugar Lake Association was the volunteer reader for Sugar Lake. During the period of record the lake level has varied 4.43 feet based on 340 readings (through April 2004). In general, water levels decline from May through September, with the exception of a slight increase in mid-July in response to several storms.

Highest Recorded (feet/date)	Lowest Recorded (feet/date)	Average reading (feet)	Ordinary High Water (feet)
989.63 (May 7, 2001)	985.2 ft (Sept. 9, 1938)	988.29 ft	988.1 ft



## **Introduction/History of your Lake/River Association**

The Sugar Lake Association (SLA) was formed in 1972 and is now a tax-exempt organization with members made up of residents and friends of Sugar Lake.

The purpose of the SLA is to: PROTECT, PRESERVE, MAINTAIN and IMPROVE your Sugar Lake environment.

An eighteen-member board administers the SLA. Each board member serves for 3 years and then is required to take a year off before being eligible to be elected again.

SLA is also a member of the Minnesota Lakes Association whose objective is to coordinate statewide information and activities by all local lake associations with state and local agencies.

As a part of the SLA, many volunteer groups and activities have been formed to further lake quality and making Sugar Lake a fun place to live, work and play.

Some of these include:

- Annual Picnic - each year all SLA members, and their families, are invited to the SLA picnic. This is FREE event and has games for the kids, door prizes, food and lots of opportunities to socialize with your Sugar Lake neighbors.
- Membership Directory - every two years a complete list of all members is published and distributed to all SLA members.
- Educational programs are available at the annual picnic and throughout the summer months in the newsletter.
- Water Monitoring - since 1980 SLA has monitored the quality and clarity of the lake.
- Water Quality Improvement - formed in 1999 to coordinate projects and ideas to improve the lake including tips such as buffer zones and runoff solutions.
- Exotic plant control - active programs are in place to track and treat eurasian water milfoil and curlyleaf pond weed.
- Water Patrol - with the help of the Wright County Sheriff, we have our own, deputized, water patrol to help with lake activities.
- Fish Traps - we have constructed and installed fish traps to help keep rough fish out of Sugar Lake.
- Sugar Lake News - from April to October, a newsletter is published and mailed to all members.
- Other Activities include: Fishing Contest, Sugar Lights Night, Boat Parade, etc.
- How are SLA programs funded? Each year dues are asked of each member. For the current year, the dues are \$20.00. Balances of our accounts and activities of SLA are detailed in the SLA Newsletter.

SLA also conducts a few fund raising activities such as raffles. Additionally, since SLA is a tax-exempt organization, many people and organizations give charitable gifts to SLA to help us further our goals of improving Sugar Lake. Other members are also using SLA as a part of their

estate plan for gifts in the future. These contributions are all considered "charitable" and are tax deductible.

The 1999 Lake Assessment Program report prepared by the MPCA presented the following history of development and Lake Association activities:

- 1959 Dwellings around Sugar Lake are constructed
- 1972 Formation of the Sugar Lake Association (SLA).
- 1986 Many Sugar Lake dwellings are remodeled.
- 1987 Major septic systems up-grades are accomplished
- 1995 Formed an advisory board to identify how to maintain/improve water quality in Sugar Lake over the next ten years. Amended by-laws to allow for formation and application for Federal 501 (c)3 (tax exempt) status with the Internal Revenue Service.
- 1996 Awarded status as a 501 (c)3 organization. Met with Wright County Planning and Zoning, Soil and Water Conservation District, and the Department of Natural Resources to establish watershed boundaries and gain their support for establishment of a Lake Improvement District (LID). SLA Board approved to proceed with obtaining a Lake Improvement status. SLA joins the Minnesota Lakes Association.
- 1997 Filed petition to form LID with Wright County. Withdrew petition application upon advice from County Attorney. Held public information meeting with watershed property owners, less than 10 percent attended.
- 1998 SLA Advisory board invited opponent to LID to attend all meetings and help formulate proposed by-laws which were sent with the 1999 petition. SLA took part in the Sustainable Lakes Project.
- 1999 SLA Board of Directors approved sending a packet containing a preference voting sheet and petition requesting a LID and additional information to all property owners. SLA Board of Directors voted to have Advisory Board present the application for a LID to the County Board of commissioners. SLA participated in MPCA's Lake Assessment Program.
- 1999 The SLA formed a Water Quality Improvement Committee (WQIC) in September 1999. This group was responsible for the following tasks and projects:
  - a. Identification and mapping of all culverts;
  - b. Identification of major stormwater runoff areas;
  - c. Establishment of a program to routinely monitor and record rainfall volume at four sites around the lake;
  - d. Establishment of a stormwater turbidity monitoring program which records measurements after every major rain event;
  - e. Secured and mapped vegetative buffer strips;

- f. Continued participation in the Citizen Lake Monitoring Program (CLMP).
- g. Completed survey of on-site wastewater treatment systems (ISTS, or septic systems), and shared data with County;
- h. Established a non-phosphorus fertilizer program to promote and distribute this product before it was widely available in Wright County.

- 2000 Sensitive vegetation areas identified and buoys were purchased for annual installation;
- 2001 Aquatic Vegetation Committee continued to monitor and treat Eurasian watermilfoil. A “Milfoil Water Team” was established to conduct scheduled surveys for new milfoil infestations.
- 2002 Aquatic Vegetation Committee assigned to identify location and treatment options for control and management of curlyleaf pondweed.
- 2003
- 2004 SCUBA divers retained to survey entire littoral zone of lake for presence of invasive exotic species at a cost of \$9,200.
- 2005 Geographic Positioning System (GPS) transmitter and software purchased for use in mapping and evaluating location of invasive exotic treatments.

These projects have served as the basis and baseline by which to develop new projects and priorities in 2003 and 2004.

## 1. Water Quality

Citizen volunteers from the various Crow Wing Lake Associations have participated in the Minnesota Pollution Control Agency's (MPCA) Citizen Lake Monitoring Program (CLMP) since 1974, recording secchi disc transparency – a measure of water clarity. James E. Kastl has been the primary volunteer in the CLMP from Sugar Lake.

On the MPCA's web-site link, "Lake Water Quality Database," secchi data are reported. The MPCA web site also provides a summary of average concentrations of total phosphorous (the primary nutrient found in lakes in this region) and chlorophyll *a* (the pigment in plants that photosynthesizes, and thus a good measure of plant concentration or "productivity").

In addition to the MPCA CLMP, Sugar Lake has worked with the Wright County Soil and Water Conservation District, and with RMB Laboratories in Detroit Lakes to monitor secchi depth and other measures of water quality. Data from 2002-2004 was retrieved from the RMBL web-site, <http://www.rmbel.info>.

One application of secchi disc transparency data is to convert the clarity measurements into a Carlson Trophic Status Index (TSI) score. The Carlson Trophic Status Index (TSI) is a tool used to summarize several measurements of water quality into one index value, which can be used to compare a lake to other lakes, or to historic/future data as a measure of degradation or improvement. In many ways, the index can be viewed as a measure of the potential for algal productivity. Since most people value lakes with low algae productivity, the lower the TSI value the healthier the lake. Specifically:

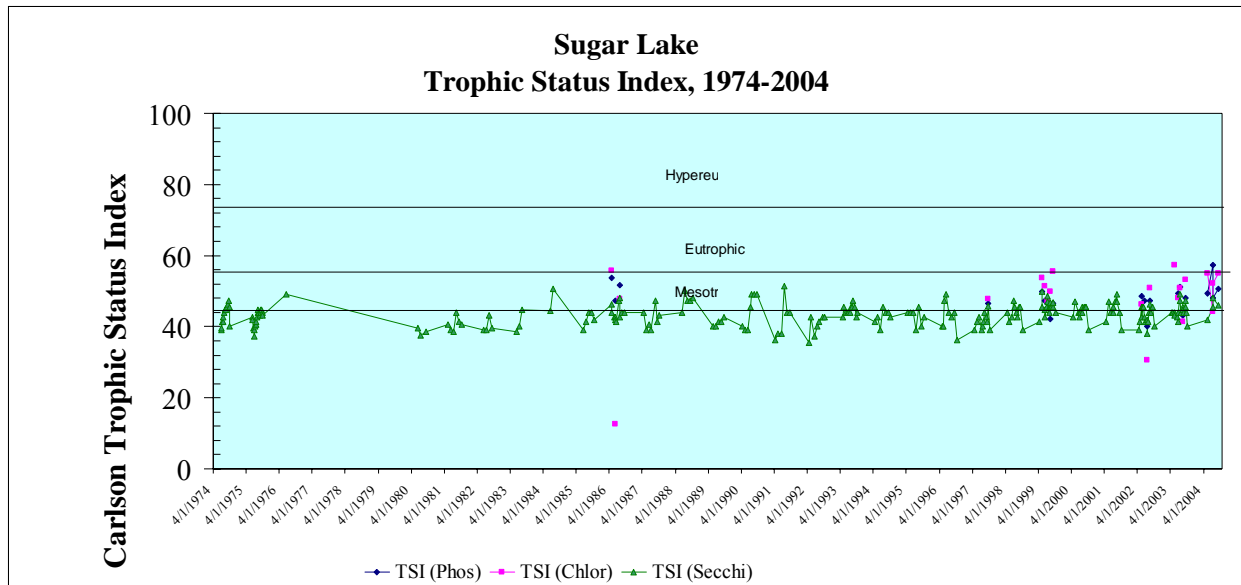
<u>TSI Range</u>	<u>Trophic Status</u>	<u>Characteristics</u>
0-40	Oligotrophic	Clean Lake
41-50	Mesotrophic	Temporary algae & aquatic plant problems
50-70	Eutrophic	Persistent algae & aquatic plant problems
Greater than 70	Hypereutrophic	Extreme algae & aquatic plant problems

Based on the data provided on the MPCA and RMBL websites, an average concentration (or depth) for the key TSI parameters can be determined, and the associated TSI score calculated.

Year	Chlorophyll <i>a</i> (µg/L)	Total Phosphorus (µg/L)	Secchi Depth (feet)	Average TSI
1974	---	---	10.5	43.5
1975	---	---	11.3	42.3
1976	---	---	7.0	44.6
1980	---	---	14.5	38.6
1981	---	---	12.6	40.7
1982	---	---	13	40.3
1983	---	---	12.3	14.2
1984	---	---	7.9	47.7
1985	---	---	11.5	42.0
1986	26.0	6.4	10.1	43.9
1987	---	---	11.6	42.1
1988	---	---	8.0	47.3
1989	---	---	12.2	41.1
1990	---	---	10.1	44.5
1991	---	---	12.2	41.9
1992	---	---	13.4	40.3
1993	---	---	9.7	44.5
1994	---	---	11.0	42.7
1995	---	---	11.0	42.7
1996	---	---	11.2	42.9
1997	19.0	5.8	12.0	41.6
1998	---	---	10.3	43.7
1999	19.0	8.8	8.0	46.4
2000	---	---	9.9	44.2
2001	---	---	9.6	44.8
2002	18.5	4.7	11.0	43.0
2003	20.0	8.4	9.8	45.1
2004	27.3	9.3	9.2	49.5

These data suggest that water quality in Sugar Lake routinely exhibits “mesotrophic” conditions (a TSI score above 40 but below 50).

Figure X shows the long-term trends in Trophic Status Index values the years for which data are available.



A second method of assessing water quality and determining whether your water body is the “best that it can be” is to compare it to other lakes of similar morphology, geology, and land uses. Listed below are ranges of common measures of water quality based on many years and locations of water quality. The tables below are adapted from the MN Pollution Control Agency and show common water quality ranges for lakes within the Central Hardwood Forest Eco-region.

**Table 4. Average Summer Water Quality and Trophic Status Indicators**

Parameter	Typical Range: Central Hardwood Forest Eco-region (25 <sup>th</sup> -75 <sup>th</sup> Percentile)	Sugar Lake Total Observed Range
Total Phosphorus (µg/L)	23 – 50	14 – 208
Chlorophyll <i>a</i> (µg/L) mean	5 – 22	12.7
Chlorophyll <i>a</i> (µg/L) maximum	7 – 37	15
Secchi disc (feet)	4.9 – 10.5	6.0 – 37.7
Total Kjeldahl Nitrogen (mg/L)	< 0.60 – 1.2	0.57 – 1.63
Nitrite + Nitrate Nitrogen (mg/L)	<0.01	<0.01 – 0.05
Alkalinity (mg/L)	75-150	140 – 170
Color (Pt-Color units)	10 – 20	10 – 20
pH	8.6 – 8.8	7.73 – 8.9
Chloride (mg/L)	4 – 10	5.2 – 10.0
Total Suspended Solids (mg/L)	2 – 6	1.3 – 6.4
Total Suspended Inorganic Solids (mg/L)	1 - 2	
Conductivity (µmhos/cm)	300 – 400	260 – 330
Total Nitrogen/Total Phosphorus ratio	25:1 – 35:1	---

A third application of these data is to compare phosphorus concentrations to the Minnesota Pollution Control Agency water quality criterion for swimming and other recreational contact. The Central Hardwood Forests ecoregion phosphorus criteria level of 45-50 micrograms per liter ( $\mu\text{g/L}$ ) serves as the upper threshold for full-support (partial) swimmable use. This concentration corresponds to Carlson's TSI values of 57-59.

Full-support of swimmable use is set at slightly lower phosphorus concentration of 40 micrograms per liter, which ensures that conditions associated with "impaired swimming" would occur less than ten percent of the summer. Phosphorus concentrations above criteria levels would result in greater frequencies of nuisance algal blooms and increased frequencies of "impaired swimming." The upper threshold for partial-support of swimmable use was set at 57 Carlson TSI units for the CHF ecoregion.

Name	Mean Total Phosphorus ( $\mu\text{g/l}$ )	Carlson's Trophic Stratus Index (phosphorus)	MPCA Swimming Criterion <sup>1</sup>
Sugar Lake	22	48.7	Full Support

## 2. Fisheries:

Status of the Fishery (as of July 6, 1998) according to the MN Dept. of Natural Resources fisheries summary:

Relative abundance estimates of fish from 1998 gill net sets consisted of three target fish species, northern pike (22.11/lift), walleye (5.56/lift), yellow perch (2.56/lift) and several non-target species, bluegill (12.44/lift), hybrid sunfish (13.50/lift), and pumpkinseed sunfish (4.11/lift). Northern pike abundance was three times the highest expected value, walleye abundance was slightly higher than expected values and yellow perch abundance was slightly below expected values for lakes similar to Sugar Lake.

The gill net catch rate for northern pike has appeared to increase from 16.22/lift in 1992 to 22.11/lift in 1998; however, mean weight per fish decreased from 2.11 lbs. to 1.62 lbs. Northern pike sampled in 1998 ranged in length from 11.2 to 30.1 inches, with a mean length of 19.3 inches. Growth was above average for Minnesota lakes as most of the fish sampled were Age I, II, and III individuals that reached 11.99, 15.63, and 17.95 inches, respectively. A mark-recapture population estimate showed that 26,004 northern pike between 11.2 and 30.1 inches were present in Sugar Lake during 1998. The 1998 creel survey on Sugar Lake indicated an overall angler catch rate of 0.20 northern pike/hour, (SE 0.02), while anglers who targeted northern pike caught 0.39 fish/hour (SE 0.10). The overall angler catch rate and the catch rate for anglers targeting northern pike were twice the average catch rates for similar lakes. All anglers caught an estimated total of 8,417 northern pike (SE 1490), and harvested 945 northern pike (SE 211).

The gill net catch rate for walleye has appeared to increase from 4.33/lift in 1992 and 5.56/lift in 1998; however, mean weight per fish decreased from 3.35 lbs. to 1.68 lbs., respectively. Walleye sampled in 1998 ranged in length from 10.7 to 26.2 inches, with a mean length of 16.5 inches. Growth was above average for Age II and IV individuals as fish reached 12.11 and 15.96 inches, respectively, while growth was below average for individuals that reached 18.05, 21.68, and 27.75 inches by Age VI, VIII and XII, respectively. Walleye fingerlings were stocked in Sugar Lake in 1988, 1990, 1992, 1994, 1996 and 1998, and survival was observed for most stocked year classes in the 1998 sample. A mark-recapture population estimate indicated that 894 walleye between 15 and 22 inches were present in Sugar Lake during 1998. The overall angler catch rate of 0.01 walleye/hour (SE 0.002), and the catch rate of anglers who targeted walleye of 0.05 fish/hour (SE 0.01), as determined from the 1998 creel survey on Sugar Lake, was lower than average catch rates for similar lakes. All anglers caught an estimated total of 563 walleye (SE 127) and harvested 333 walleye (SE 99).

The gill net catch rate for yellow perch has appeared to increase from 1.67/lift in 1992, to 2.56/lift in 1998; and mean weight per fish increased from 0.08 to 0.11 lbs., respectively. Yellow perch sampled in 1998 ranged in length from 5.8 to 7.2 inches, with a mean length of 6.3 inches. Yellow perch growth was average compared with other Minnesota lakes as Age III, IV, and V individuals reached 6.31, 7.02, and 8.46 inches, respectively.

Relative abundance estimates of fish from trap nets in 1998 consisted of four primary fish species: bluegill (50.00/set), hybrid sunfish (15.42/set), pumpkinseed sunfish (4.17/set), and green sunfish (1.42/set). Bluegill and Pumpkinseed sunfish abundance were slightly higher than expected values for lakes similar to Sugar Lake, while green sunfish abundance was well above the expected range.

The trap net catch for bluegill has appeared to increase from 42.08/set in 1992 to 50.00/set in 1998; however, mean weight per fish has remained similar at 0.10 lbs. Bluegill sampled in 1998 ranged in length from 2.6 to 7.8 inches, with a mean length of 4.9 inches. Growth was above average as Age I, II, IV and V individuals reached 3.15, 4.23, 6.46, and 7.31 inches, respectively. Representatives from the 1995 and 1996 year classes were most abundant in the 1998 survey.

The trap net catch for pumpkinseed sunfish has appeared to decrease from 6.15/set in 1992 to 4.17/set in 1998. Fish sampled in 1998 ranged in length from 2.8 to 6.2 inches, with a mean length of 4.6 inches. The trap net catch rate for hybrid sunfish has significantly increased from 7.38/set in 1992 to 15.42/set in 1998. Hybrid sunfish sampled in 1998 ranged in length from 3.1 to 8.1 inches, with a mean length of 5.3 inches. The 1998 creel survey on Sugar Lake indicated a combined angler catch rate for bluegill, pumpkinseed sunfish, and hybrid sunfish of 0.62 fish/hour, which was equal to the angler catch rate of sunfish for similar lakes. All anglers caught an estimated total of 26,090 sunfish, and harvested 7128 sunfish.

Although electrofishing has been considered the specific gear used to sample largemouth bass, the Spring trap net survey on Sugar Lake revealed a quality length frequency distribution and relative abundance. The trap nets captured 62 largemouth bass that ranged in length from 7.1 to 17.1 inches, with a mean length of 13.3 inches. Of the catchable largemouth bass (larger than 8 inches) 75% were larger than 12 inches, and the percentage larger than 15 inches was 29%. Growth of largemouth bass was average compared with other Minnesota lakes. The largest portion of the sample contained individuals from the 1992 year class, with a mean length of 14.29 inches. Other strong year classes were observed from 1991, 1994 and 1997. The 1998 creel survey on Sugar Lake indicated an overall angler catch rate of 0.13 largemouth bass/hour (SE 0.01), while anglers who targeted largemouth bass caught 0.45 fish/hour (SE 0.08). The overall angler catch rate and the catch rate for anglers targeting largemouth bass were slightly above the average angler catch rates for similar lakes. All anglers caught an estimated total of 5,489 largemouth bass (SE 985), and harvested 522 largemouth bass (SE 161).

Trap nets set during spring captured 212 black crappie, with a catch rate of 2.46/set. Black crappie sampled in 1998 ranged in length from 5.9 to 12.9 inches, with a mean length of 9.7 inches. Growth was below average compared with other Minnesota lakes as individuals reached 5.87, 7.76, 8.75, 9.85, 10.68 and 11.50 inches by Age II through VII, respectively. The 1998 creel survey on Sugar Lake indicated an overall angler catch rate of 0.01 black crappie/hour (SE 0.005), while anglers who targeted black crappie caught 0.35 fish/hour (SE 0.11). The overall angler catch rate and the catch rate for anglers targeting

black crappie were below the average catch rates for similar lakes. All anglers caught an estimated total of 422 black crappie (SE 175), and harvested 284 black crappie (SE 167).

Muskellunge were sampled using spring trap nets. Trap nets captured a total of 40 muskellunge, with a catch rate of 0.46/set. Muskellunge sampled in 1998 ranged in length from 11.2 to 46.3 inches, with a mean length of 33.8 inches. Growth was average compared with other Minnesota lakes as Age VIII, IX, X, and XI individuals reached 38.44, 42.32, 43.31, and 46.14 inches, respectively. Muskellunge fingerlings were stocked in Sugar Lake in 1987, 1988, 1989 through 1992, and 1994 through 1998; however, survival was evident from the stockings prior to 1990. The 1998 creel survey on Sugar Lake suggested an overall angler catch rate of 0.01 muskellunge/hour (SE 0.002), while the catch rate for anglers targeting muskellunge was 0.03 fish/hour (SE 0.008). The overall angler catch rate and the catch rate for anglers targeting muskellunge were comparable to the average catch rates for similar lakes. An estimated total of 563 (SE 120) muskellunge were caught, and 10 (SE 10) were harvested.

### **3. Aquatic Vegetation**

The 1999 MPCA LAP report included the following text:

The native aquatic plant communities of Sugar Lake provide critical habitat for fish and wildlife. Different zones of vegetation types can be identified along the gradient from upland to open water: emergents, floating-leaved, submerged and free-floating species. Lakes with a diversity of different plant types provide a wide range of habitat for different fish and wildlife species. In general, aquatic plants help maintain water quality because they use up nutrients that would otherwise be available to algae. They also help protect shorelines from wave action and stabilize bottom sediments.

Emergent, or shoreline aquatic plants are those that grow in moist soil or shallow water and extend above the water surface. In 1998, surveyors recorded 18 different emergent plant species along the Sugar Lake shoreline. Commonly occurring species included wild rice, narrow and broad-leaf cattail, and hardstem bulrush. Most large beds of emergents are restricted to undeveloped areas of Sugar Lake. Emergent plants are natural shoreline stabilizers because they reduce wave action that can erode shores and act as filters to reduce nutrient runoff into the lake. Emergent plants also provide important fish and wildlife cover, nesting and feeding areas. Cattail and bulrush stems and leaves persist through the winter and provide year-round benefits.

Major beds of rooted, floating-leaved vegetation occur in the northern and southern bays of Sugar Lake. Floating-leaved plants found include white and yellow waterlily, watersheild and floating-leaf pondweed. A fifth floating-leaved species, water smartweed, was recorded in the lake in 1981 (DNR Fisheries files) and may still be present but was simply not detected during the 1998 survey. Like emergent beds, waterlily beds help minimize wave action on shores and also provide shade, shelter and foraging opportunities for fish.

Submerged plants grow primarily beneath the water surface, root in the lake bottom, and may produce flowers or floating leaves that emerge out of the water. Twenty-five different submerged plants were located during the 1998 survey. The most commonly occurring species were coontail, flat-stem pondweed, muskgrass, bushy pondweed, northern watermilfoil and water celery. These species all occurred at the more than 75 percent of the sample sites in 1998 and were also all described as abundant during the 1950 survey (DNR Fisheries Lakes files), indicating that there has not been a major shift in species dominance in the past 50 years. Low growing beds of muskgrass and bushy pondweed provide cover for fish. The taller, denser foliage of coontail and northern watermilfoil are excellent invertebrate habitat. The tubers and foliage of water celery are a favorite food of canvasback ducks. Seeds of all of the pondweeds are also eaten by waterfowl and the leaves may be grazed by muskrat, deer and beaver.

Four types of free-floating duckweeds were found during the 1998 survey. Because they are not rooted in the lake bottom, the distribution of duckweeds in the lake can change with wind and wave actions and are often found in protected backwaters. As their name implies, duckweeds provide a food source for waterfowl and marsh birds.

In 1997, a lake association volunteer located an area of Eurasian watermilfoil near Sunset Point at the north end of Sugar Lake. The volunteer correctly marked the site with a home-made buoy, collected a plant sample and immediately notified the DNR. The DNR treated this site with herbicide twice in 1997 in an attempt to control the milfoil. The herbicide treatments appeared to knock back the milfoil growth, but it is unlikely that it killed all the milfoil. Milfoil was not located in Sugar Lake in 1998. In 1999, the DNR surveyed the lake for milfoil in mid-May and did not locate any. In early August, a SCUBA diver found four Eurasian Watermilfoil plants not far from Sunset Point, and the plants were hand-pulled. The DNR re-surveyed the lake in mid-August 1999 and did not find any more EWM, but it is very likely still present in the lake in low abundance. The DNR will continue to monitor the lake for Eurasian milfoil in 2000 and arrange herbicide treatments if necessary.

The DNR does not believe it is reasonable to eradicate Eurasian watermilfoil from Sugar Lake, based on our experience over the past ten years as well as studies from other lakes. The DNR will continue to survey Sugar Lake by boat for milfoil and will initiate herbicide treatments when necessary.

#### **4. Wildlife**

The “Blue Book,” *Developing a Lake Management Plan* notes that:

“Minnesota’s lakes are home to many species of wildlife. From our famous loons and bald eagles to muskrats, otters, and frogs, wildlife is an important part of our relationship with lakes. In fact, Minnesota’s abundant wildlife can be attributed largely to our wealth of surface water. From small marshes to large lakes, these waters are essential to the survival of wildlife.

The most important wildlife habitat begins at the shoreline. The more natural the shoreline, with trees, shrubs and herbaceous vegetation, the more likely that wildlife will be there. Just as important is the shallow water zone close to shore. Cattail, bulrush, and wild rice along the shoreline provide both feeding and nesting areas for wildlife. Loons, black terns and red-necked grebes are important Minnesota birds that are particularly affected by destruction of this vegetation. Underwater vegetation is also important to wildlife for many portions of their life cycle, including breeding and rearing of their young.

The primary agency charged with the management of Minnesota’s wildlife is the Department of Natural Resources, Division of Fish and Wildlife, Wildlife Section. For Sugar Lake, the DNR Wildlife contact is: Fred Bengtson, Assistant Wildlife Manager, St. Cloud, Phone: 320-255-4279, e-mail: [fred.bengtson@dnr.state.mn.us](mailto:fred.bengtson@dnr.state.mn.us)

## 5. Exotic Species

The 1999 MPCA LAP noted:

The Minnesota Department of Natural Resources (DNR) Fisheries staff conducted an extensive vegetation survey of Sugar Lake in July 1998. They identified a total of 50 different aquatic plant species and recorded vegetation growing to a maximum depth of 20 feet. The depth to which plants grow in this lake, the high number of plant species recorded, and the low abundance of exotic species are indications of a healthy lake.

DNR Fisheries began monitoring the vegetation of Sugar Lake in 1950 (DNR Fisheries Lake files) and a survey was repeated in 1971, and then about every five years after that. Since 1991, annual vegetation surveys have been conducted on this lake by the DNR as part of the management of Eurasian watermilfoil. A comparison of past vegetation surveys indicates that the types of plants that occur in Sugar Lake has not changed much in the past 50 years. However, the amount of shoreline vegetation has decreased.

The LAP report also reviewed the types and values of aquatic plants in Sugar Lake, including those which provide critical fisheries and wildlife habitat, and help prevent erosion and stormwater runoff, as well as invasive exotic species such as purple loosestrife, Eurasian watermilfoil, and curlyleaf pondweed.

The LAP study also recorded that curlyleaf pondweed, an invasive exotic form of aquatic vegetation was:

“...first reported in Sugar Lake in 1990 (DNR Fisheries Lake Files) but it was introduced into Minnesota nearly 100 years ago and has been present in Wright County lakes for decades. Many of these (lakes) support abundant populations of curlyleaf pondweed, which can dominate the plant community and form dense mats throughout the spring and early summer. However, in Sugar Lake this is not the case. In 1998, curlyleaf pondweed was only found in 20 percent of the sample sites. In 1999, curlyleaf pondweed was also not very abundant in the lake. Lakes where curlyleaf pondweed dominates typically do not support diverse native plant communities. The present of a healthy and diverse native plant community help(s) limit the abundance of curlyleaf in Sugar Lake.”

## 6. Land Use and zoning

The water quality of a lake or river is ultimately a reflection of the land uses within its watershed. While the specific impacts to a lake from various land uses vary as a function of local soils, topography, vegetation, precipitation, and other factors, it is ultimately the land uses which citizens have the most control over through prudent zoning

Many zoning regulations are based upon the Shoreland Management Act and/or the Minnesota Department of Natural Resources (DNR) classification of a given lake. The DNR has classified all lakes within Minnesota as General Development (GD), Recreational Development (RD), or Natural Environmental (NE) lakes, and assigned a unique identification number to the lake for ease of reference. Counties in turn have used these classifications as a tool to establish minimum lot area (width and setbacks) that is intended to protect and preserve the character reflected in the classification.

The Wright County web-site provides a link to the Planning and Zoning ordinances for the county: <http://www.co.wright.mn.us/departments/pandz/forms>. On any shoreland the permissible density and setbacks for virtually all new use are determined by the lake or river classification standards established by the Department of Natural Resources. Sugar Lake (#86-0233) is a General Development Lake.

The Wright County zoning standards for each of the respective classifications are:

<b>Standards:</b>	<b>General Development</b>	<b>Recreational Development</b>	<b>Natural Environment</b>	<b>River – Agriculture</b>
Structure setback from NOHW	75 feet	100 feet	200 feet	100 feet
Structure setback from Bluff Height	30 feet	30 feet	30 feet	30 feet
Lot Size	--	--	2 acres	--
Lot Width	--	--	200 feet	150 feet
Lot Depth	--	--	200 feet	--
Side Yard Setback	--	--	20 feet	--
Height	2 1/2 stories (35 feet)	2 1/2 stories (35 feet)	2 1/2 stories (35 feet)	2 1/2 stories (35 feet)
Elevation of lowest floor above highest known water level	4 feet	4 feet	4	4 feet
Water Oriented Accessory Structure setback from NOHW	10 feet	10 feet	Not permitted	10 feet

Clearly any local municipal jurisdiction may have additional (and usually more restrictive) standards as well.

Most lakes have numerous properties that are “grand fathered,” or developed prior to the establishment of these restrictions. In general, these pre-existing uses are allowed to remain unless they are identified as a threat to human health or environment.

## **7. Managing water surface use conflicts**

The goal of lake management is to ensure that the lake can continue to provide the benefits that attract homeowners and users. However, conflicts among uses arise almost invariably. Successful resolution of conflicts lies in the ability of the users to work collaboratively to arrive at acceptable compromises.

The primary agency responsible for managing surface water use conflicts is the Minnesota Department of Natural Resources, Bureau of Information and Education. The Boat and Water Safety Section within the Bureau oversees surface water use and is in charge of administering the Water Surface Use Management (WSUM) program. The goal of this program is to enhance the recreation use, safety and enjoyment of the water surfaces in Minnesota and to preserve these water resources in a way that reflects the state's concern for the protection of its natural resources.

Within this context, any governmental unit may formulate, amend or delete controls for water surface use by adopting an ordinance. Submit the ordinance for approval by the MDNR Boat and Water Safety Coordinator by calling 1 (800) 766-6000 or (651) 296-3336. To gain approval the ordinance must:

- Where practical and feasible accommodate all compatible recreational uses;
- Minimize adverse impacts on natural resources
- Minimize conflicts between users in a way that provides for maximum use, safety and enjoyment, and
- Conform to the standards set in WSUM Rules.

From a practical standpoint, any community considering this action should also consult with their local law enforcement agency (that will largely enforce the local ordinance) to ensure that any restrictions can be effectively enforced.

An alternative or complementary approach is to encourage education and a "community standard" of acceptable behavior. Annual distribution of state standards for hours of operation, setbacks from shorelands, loon nests, swimming areas, and other hazards or sensitive areas helps create "peer pressure" to minimize the types of behavior that tend to lead to the most conflicts.

**8. Public water access**

Research has shown that Minnesotans rely heavily upon public access sites to access lakes and rivers. A 1988 boater survey conducted by the University of Minnesota showed that three-fourths of the state’s boat owners launch a boat at a public water access site at least once a year. In addition, over 80 percent of boat owners report using public water access sites for recreation activities other than boating.

The primary agency responsible for public water accesses in Minnesota is the Minnesota Department of Natural Resources, Trails and Waterways Unit. They are responsible for the acquisition, development and management of public water access sites. The DNR either manages them as individual units or enters into cooperative agreements with county, state, and federal agencies, as well as local units of government such as townships and municipalities. The DNR’s efforts to establish and manage public water access sites are guided by Minnesota Statutes and established written DNR policy. The goal of the public water access program is free and adequate public access to all of Minnesota’s lake and river resources consistent with recreational demand and resource capabilities to provide recreation opportunities.

According to the Minnesota Department of Natural Resources, Division of Fisheries Surveys, there two points of public access on the Sugar Lake, as shown below:

**Public Access Information**

<b>Ownership</b>	<b>Type</b>	<b>Description</b>
Minnesota DNR	Concrete	State owned access is located at the northeast end in S. 36.
Minnesota DNR	Concrete	State owned access is located at the south end in S.11.

### **Summary of Visioning/Planning Session**

A visioning session was held June 14, 2003 at Camp Friendship. The following paragraph, from the June 2003 SLA newsletter, summarizes the event.

Between 60 and 70 people attended the Healthy Lakes visioning session held at Camp Friendship June 14. Also in attendance were Paul Diedrich from the DNR and Brad Wozney from Wright County Soil and Water. The session was facilitated by Doug Malchow. After a brief update on lake status by the DNR and Wright Soil & Water small groups were formed to discuss and vote on areas of concern. When the results were tallied, three areas of major concern were identified: water quality, vegetation/exotic species, and fisheries. Attendees then voted with their feet and gathered in one of the three groups. The groups discussed desired outcomes, defined benchmarks, and identified actions to take. All three groups scheduled subsequent meetings to refine future plans. Next steps in the Healthy Lakes Partnership will be to continue activities identified in the groups, update the lake management plan, and begin work on identified goals.

The meeting was an unqualified success. Attendance was good and resulted in many new active committee members. The focus areas identified at the visioning session have evolved to our present day focus areas of education, water quality, and vegetation. Education was identified as the critical issue in all areas. This prompted the formation of a stand alone education committee to coordinate education related activities for all areas. After several fisheries group meetings it was decided that fishery improvement would be best accomplished through water quality and vegetation improvement.

## **Prioritized Goals and Action Plan**

The final chapter of our lake management plan summarizes the conclusions and priority action we have chosen to work on at this time. Specifically, for each priority action we have down our best to answer (for each goal presented):

- What are the criteria for measuring success (measured as outcomes, not effort)?
- What is our schedule for implementation (What needs to happen in the next 30 days, 60 days, one-year out)?
- Who is responsible for implementation or measurement (name names!)?
- What is the budget for this action/goal?
- Is this an on going action/goal, or a one-time effort? If on-going will we require additional funds for full implementation?

Following this format, the remaining pages identify our top priorities, what our goals for each priority are, and how, who, and when we will implement action for each of these priorities.

### **Priority 1: Education Committee**

Goals and Objectives: Continue ongoing educational efforts for adults, teens, and children who are lake residents, and expand those efforts to keep our members engaged in learning. Increase number of people in the Association who are interested in having a positive impact on Sugar Lake.

### **Action Plan and Implementation Schedule for Education Subcommittee:**

1. Establish a network of “Area Communicators”; one person from each area of the lake to share specific SLA information and/or educational information, and to gather input from their neighbors to share with SLA board members. Re-align lake areas to reflect current conditions, purchase and publish maps detailing areas including property owner information and list area communicator. Cost \$800.
  - a. Status: Complete. Individuals for each area have been identified. Doc Williams has volunteered to lead the group. Area re-alignment is complete and updated property maps have been purchased for inclusion in the 2004-2005 directory.
2. Purchase caps and t-shirts to identify Sugar Lake Association volunteers to the general membership to increase awareness of the volunteer activity around the lake and invite more participation. Estimated cost \$250.
  - a. Status: Decide on design and implementation plan by October 2004 meeting. Implement April 2005.
3. Form a “Shoreline Gardeners Group” to bring people on the lake together who are interested in learning more about “Lakescaping” and/or shoreline restoration. Established in 2004 as the Sugar Lakescapers
  - a. Purchase plants and join efforts to restore native vegetation to several public and high profile areas on the lake. Estimated cost \$1000
  - b. Provide signs to place next to current projects to generate interest and identify plants as people tour the lake during the summer. No cost, signs donated.

- c. Status: Complete. Sugar Lakescapers formed. Two native planting projects are complete. Both projects will continue to be monitored.
- 4. Develop a Sugar Lake Calendar for 2005 with pictures taken of people, projects, wild life, and fun lake activities from around the lake. Mark important SLA dates/events. Include inserts on each page with educational information and reminders specific to each month. Estimated cost \$2500
  - a. Status: Pictures and material being collected in 2004/5. Identify funding for calendar spring 2005.
- 5. Develop simple experiments for kids, designed to teach them about the water quality of Sugar Lake. Print one in each monthly newsletter during the summer months with instructions on how to collect data. Turn in data sheets at the Sugar Lake picnic to get a special prize along with a "Sugar Lake Jr. Limnologist " certificate. Recognize the participants in future newsletter editions. Estimated cost \$0
  - a. Status: Complete. Experiments published in newsletter and available on web site
- 6. Fund the \$500 Sugar Lake Association scholarship.
  - a. Status: Complete. 2004 scholarship awarded to Kristin Beltrand. Winning essay published in August newsletter. All essays published on web.

**Priority 2: Water Quality Improvement Committee (WQIC)**

Goals and Objectives: Through the process of meeting with a greatly expanded committee the following goals and action plans have been identified:

- 1. Acquire a copy of ERSI ArcView 9.0 GIS (Geographic Information Systems) software .
  - a. A significant portion of the data currently collected and used by the Sugar Lake Association is geographic in nature. The grant application to acquire the software contained the following paragraph explaining why we need it and what will be done with it.
    - i. The Sugar Lake Association, a 501(c)3 organization, is ready to take full advantage of a Geographic Information System in its work to maintain and improve water quality in Sugar Lake, Wright County, Minnesota. Volunteers routinely and regularly collect and report on geographic related data for the benefit of association members. Much of the data is property related. The Association currently works with Wright County GIS staff to obtain property maps. Data collected now is published to the membership primarily in tabular format making it difficult to see how the data is interrelated. The GIS software would provide a focal point to both organize and use the data presently collected. Data sources have been identified, and the software users have been identified and are willing to invest the time required to learn how to use the software. Data presently collected includes water quality information such as secchi depth, total phosphorus, chlorophyll. Property related data includes septic system status, shoreline buffer strip rating, and planned for 2005 is a hard surface percentage by property. Maps are maintained that show all culvert locations in and out of the lake, major run-off locations, roadway run-off areas, buoy locations and purpose. Invasive species Eurasian milfoil and

curlyleaf pondweed are present in Sugar Lake. The areas of infestation are mapped with GPS coordinates later used to apply chemical treatment. Emergent vegetation is being mapped winter of 2005 to provide a baseline to detect changes in future years. GIS software will give the Sugar Lake Association the tool it needs to pull all this existing information together and display it in meaningful ways to property owners, watershed residents, and local government to promote improving water quality in Sugar Lake.

2. Septic Systems Upgrades and Improvements:
  - a. Develop plan for replacement or upgrading of nonconforming systems
  - b. Expand inspection program to include entire watershed (not just first tier residences);
  - c. Provide information and education on proper maintenance, including targeting new property owners.
3. Stormwater Runoff Monitoring:
  - a. Increase the number of locations where runoff testing data is taken.
  - b. Publish this information and use it to evaluate where potential new projects are needed and the effectiveness of existing projects.
4. Produce and distribute “low impact Lake Living” information including specific materials on the following themes:
  - a. Leaf and organic debris management;
  - b. Septic care and maintenance, including information on management structures, area vendors, care in cold weather, and products which should be avoided if using ISTS.
  - c. Stormwater management “best management practices.”
5. Evaluate impervious surface impact, and promote idea of minimizing or mitigating impervious footprint.
6. Identify and implement additional new vegetative buffer sites.

#### **Action Plan and Implementation Schedule for Water Quality Subcommittee:**

1. Water Quality Monitoring. Increase the number of individuals taking turbidity readings from 3 to 5. Purchase one additional turbidity meter to support this activity. Cost \$50
  - a. Status: Additional volunteers have been identified. Need to request funding.
2. Septic System inventory. Update existing survey information with county records. Publish survey results again by area highlighting positive changes since last publication. Meet again with county to discuss how they can help with non-conforming systems. Add septic data to map information created with GIS software. Cost \$0
  - a. Status: Ready for publication in early summer newsletter
3. Identify and map sub-watersheds within the Sugar Lake watershed. With the help of Wright County SWCD and the MN DNR use ArcView GIS software we have requested to map the sub-watersheds.

4. Enroll additional Sugar Lake Association members in Shoreland Volunteer training. The SLA board authorized payment of tuition for 10 members. Cost \$600
  - a. Status: 4 members completed training in 2004. 6 additional are scheduled for March 12, 2005 training at Ney Nature Center in Maple Lake.

**Priority 3: Aquatic Vegetation Committee**

Goals and Objectives: Update map of emergent vegetation, identify potential areas to re-vegetate using native emergent vegetation; establish a sustainable program for treating curlyleaf pondweed, and identify and train volunteers to identify and treat invasive exotic plants.

**Action Plan and Implementation Schedule for Aquatic Vegetation Subcommittee:**

1. Identify one additional volunteer to take a training class in Curly Leaf Pondweed management. Cost \$15.
  - a. Status: Volunteer not identified. Shoreland Education workshops are scheduled for spring 2005.
2. Map hard stem bulrushes during the winter of 2004-2005. This is part of the water quality GIS software project. GPS readings will be taken in the winter months of 2005 for entry in GIS software summer 2005. Publish maps to membership. No additional cost for this action item.
3. Add two additional buoys to identify and protect areas with hardstem bulrushes. Estimated cost \$250
  - a. Status: not funded at this time.
4. Develop Certified Aquatic Plant Management Program (CAPP) for the DNR, apply for and obtain necessary permits, using existing SLA owned equipment purchase and apply chemicals to treat exotic plant species in Sugar Lake. Estimated cost \$10,000.
  - a. Status: Work on CAPP has started as of Feb 2005. Program on track for 2005 treatments.
5. Sugar Lake dive team to continue experiments placing chemical at base of deeper water milfoil plants. Estimated cost \$100.

## Glossary

**Aerobic:** Aquatic life or chemical processes that require the presence of oxygen.

**Algal bloom:** An unusual or excessive abundance of algae.

**Alkalinity:** Capacity of a lake to neutralize acid.

**Anoxic:** The absence of oxygen in a water column or lake; can occur near the bottom of eutrophic lakes in the summer or under the ice in the winter.

**Benthic:** The bottom zone of a lake, or bottom-dwelling life forms.

**Best Management Practices:** A practice determined by a state agency or other authority as the most effective, practicable means of preventing or reducing pollution.

**Bio-accumulation:** Build-up of toxic substances in fish (or other living organism) flesh. Toxic effects may be passed on to humans eating the fish.

**Biological Oxygen Demand:** The amount of oxygen required by aerobic microorganisms to decompose the organic matter in sample of water. Used as a measure of the degree of water pollution.

**Buffer Zone:** Undisturbed vegetation that can serve as to slow down and/or retain surface water runoff, and assimilate nutrients.

**Chlorophyll a:** The green pigment in plants that is essential to photosynthesis.

**Clean Water Partnership (CWP) Program:** A program created by the legislature in 1990 to protect and improve ground water and surface water in Minnesota by providing financial and technical assistance to local units of government interested in controlling nonpoint source pollution.

**Conservation Easement:** A perpetual conservation easement is a legally binding condition placed on a deed to restrict the types of development that can occur on the subject property.

**Cultural eutrophication:** Accelerated “aging” of a lake as a result of human activities.

**Epilimnion:** Deeper lakes form three distinct layers of water during summertime weather. The epilimnion is the upper layer and is characterized by warmer and lighter water.

**Eutrophication:** The aging process by which lakes are fertilized with nutrients.

**Eutrophic Lake:** A nutrient-rich lake – usually shallow, “green” and with limited oxygen in the bottom layer of water.

**Exotic Species:** Any non-native species that can cause displacement of or otherwise threaten native communities.

**Fall Turnover:** In the autumn as surface water loses temperature they are “turned under” (sink to lower depths) by winds and changes in water density until the lake has a relatively uniform distribution of temperature.

**Feedlot:** A lot or building or a group of lots or buildings used for the confined feeding, breeding or holding of animals. This definition includes areas specifically designed for confinement in which manure may accumulate or any area where the concentration of animals is such that a vegetative cover cannot be maintained. Lots used to feed and raise poultry are considered to be feedlots. Pastures are not animal feedlots.

**Groundwater:** water found beneath the soil surface (literally between the soil particles); groundwater is often a primary source of recharge to lakes.

**Hardwater:** Describes a lake with relatively high levels of dissolved minerals such as calcium and magnesium.

**Hypolimnion:** The bottom layer of lake water during the summer months. The water in the hypolimnion is denser and much colder than the water in the upper two layers.

**Impervious Surface:** Pavement, asphalt, roofing materials or other surfaces through which water cannot drain. The presence of impervious surfaces can increased the rates and speed of runoff from an area, and prevent groundwater recharge.

**Internal Loading:** Nutrients or pollutants entering a body of water from its sediments.

**Lake Management:** The process of study, assessment of problems, and decisions affecting the maintenance of lakes as thriving ecosystems.

**Littoral zone:** The shallow areas (less than 15 feet in depth) around a lake’s shoreline, usually dominated by aquatic plants. These plants produce oxygen and provide food, shelter and reproduction areas for fish & animal life.

**Local Unit of Government:** A unit of government at the township, city or county level.

**Mesotrophic Lake:** A lake that is midway in nutrient concentrations (between a eutrophic and oligotrophic lake). Characterized by periodic problems with algae blooms or problem aquatic vegetation.

**Native Species:** An animal or plant species that is naturally present and reproducing.

**Nonpoint source:** Polluted runoff – nutrients or pollution sources not discharged from a single point. Common examples include runoff from feedlots, fertilized lawns, and agricultural fields.

**Nutrient:** A substance that provides food or nourishment, such as usable proteins, vitamins, minerals or carbohydrates. Fertilizers, particularly phosphorus and nitrogen, are the most common nutrients that contribute to lake [eutrophication](#) and nonpoint source pollution.

**Oligotrophic Lake:** A relatively nutrient-poor lake, characterized by outstanding water clarity and high levels of oxygen in the deeper waters.

**Nutrient:** A substance that provides food or nourishment, such as usable proteins, vitamins, minerals or carbohydrates. Fertilizers, particularly phosphorus and nitrogen, are the most common nutrients that contribute to lake [eutrophication](#) and nonpoint source pollution.

**pH:** The scale by which the relative acidity or basic nature of waters are assessed,

**Photosynthesis:** The process by which green plants produce oxygen from sunlight, water and carbon dioxide.

**Phytoplankton:** Algae – the base of the lake’s food chain, it also produces oxygen.

**Point Sources:** Specific sources of nutrient or pollution discharge to a water body, i.e., a stormwater discharge pipe.

**Riparian:** The natural ecosystem or community associated with river or lake shoreline.

**Secchi Disc:** A device measuring the depth of light penetration in water.

**Sedimentation:** The addition of soils to lakes, which can accelerate the “aging” process by destroying fisheries habitat, introducing soil-bound nutrients, and filling in the lake.

**Spring turnover:** After ice melts in the spring, warming surface water sinks to mix with deeper, colder water. At this time of year all water is the same temperature.

**Thermocline:** During summertime deeper lakes stratify by temperature to form three discrete layers; the middle layer of lake water is known as the thermocline.

**Trophic Status:** The level of growth or productivity of a lake as measured by phosphorus, content, algae abundance, and depth of light penetration.

**Watershed:** The surrounding land area that drains into a lake, river, or river system.

**Zooplankton:** Microscopic animals.

## Common Biological or Chemical Abbreviations

BOD	Biological Oxygen Demand
°C	degree(s) Celsius
cfs	cubic feet per second (a common measure of rate of flow)
cfu	colony forming units (a common measure of bacterial concentrations)
chl <i>a</i>	Chlorophyll <i>a</i>
cm	centimeter
COD	Chemical Oxygen Demand
Cond	conductivity
DO	dissolved oxygen
FC	fecal coliform (bacteria)
ft	feet
IR	infrared
l	liter
m	meter
mg	milligram
ml	milliliter
NH <sub>3</sub> -N	nitrogen as ammonia
NO <sub>2</sub> -NO <sub>3</sub>	nitrate-nitrogen
NTU	Nephelometric Turbidity Units, standard measure of turbidity
OP	Ortho-phosphorus
ppb	parts per billion
ppm	parts per million
SD	Standard Deviation (statistical variance)
TDS	total dissolved solids
TN	total nitrogen
TP	total phosphorus
TSI	trophic status index
TSI (C)	trophic status index (based on chlorophyll <i>a</i> )
TSI (P)	trophic status index (based on total phosphorus)
TSI (S)	trophic status index (based on secchi disc transparency)
TSS	total suspended solids
µg/l	micrograms per liter
µmhos/cm	micromhos per centimeter, the standard measure of conductivity
UV	Ultraviolet

## **Guide to common acronyms**

### ***State and Federal Agencies***

BWSR	Board of Soil & Water
COE	U.S. Army Corps of Engineers
CRP	Conservation Reserve Program - A federal government conservation program
DNR	Department of Natural Resources
DOJ	United States Department of Justice
DOT	Department of Transportation
DTED	Department of Trade and Economic Development
EPA	U.S. Environmental Protection Agency
EQB	MN Environmental Quality Board
LCMR	Legislative Commission on Minnesota Resources
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
NRCS	Natural Resource Conservation Service
OEA	MN Office of Environmental Assistance
OSHA	Occupational Safety and Health Administration
RIM	Reinvest In Minnesota - a State of Minnesota Conservation Program
SCS	Soil Conservation Service
SWCD	Soil & Water Conservation District
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USFWS	United States Fish & Wildlife Service

### ***Regional, watershed, community development, trade and advocacy groups***

AMC	Association of Minnesota Counties
APA	American Planning Association
COLA	Coalition of Lake Associations
IF	Initiative Foundation
LMC	League of Minnesota Cities
MAT	Minnesota Association of Townships
MLA	Minnesota Lakes Association
MSBA	Minnesota School Board Association
MCIT	Minnesota Counties Insurance Trust
Mid-MnMA	Mid-Minnesota Association of Builders
MLA	Minnesota Lakes Association
MnSCU	Minnesota State Colleges and Universities
RCM	Rivers Council of Minnesota
TIF	Tax Increment Financing

### ***Codes and Regulations***

103B.301	The Minnesota law that regulates non-metro county water plans
ADA	American Disabilities Act
B & B	Bed and Breakfast
BOA	Board of Adjustment
Chapter 70/80	Individual Sewage Treatment Standards
CIC Plat	Common Interest Community Plat
Class V	Class Five “Injection” well; any well which receives discharge
CSAH	County State Aid Highway
CUP	Conditional Use Permit
CWA	Clean Water Act
EAW	Environmental Assessment Worksheet
EIS	Environmental Impact Statement
EOA	Equal Opportunity Act
FOIA	Freedom of Information Act
GD	General Development (lake)
GLAR	Greater Lakes Area Association of Realtors
IAQ	Indoor Air Quality
ISTS	Individual Sewage Treatment System
LMP	Lake Management Plan
LQG	Large Quantity Generator (of hazardous waste)
MAP	Minnesota Assistance Program
OHW	Ordinary High Water
PUD	Planned Unit Development
RD	Rural Development (lake)
ROD	Record of Decision
ROW	Right-of-Way
SBC	State Building Code
SDWA	Safe Drinking Water Act
SF	Square feet
SIZ	Shoreland Impact Zone
SQG	Small Quantity Generator (of hazardous waste)
SWMP	Stormwater Management Plan
UBC	Universal Building Code