8 Lake Harriet

History

Lake Harriet, named after Harriet Lovejoy Leavenworth, wife of Colonel Leavenworth, is a deep, glacial kettle lake generally remaining strongly stratified through October. Colonel W.S. King donated a majority of the lake (360 acres) and surrounding areas (55 acres) to the Minneapolis Park & Recreation Board (MPRB) in 1885 with the remainder being acquired from 1883-1898 and 1921. Lake Harriet offers many recreational activities including sailing, swimming, and fishing (Figure 8A). On its shores, people can enjoy concerts at the bandshell and the many gardens surrounding the lake. In 2006, both of the DNR-funded floating docks in Lake Harriet were extended.

In general, topographical changes to Lake Harriet have been minimal. A marshland on the northeast corner of the lake was filled to make room for the parkway, but it was deemed too expensive to do the same to the wetland off the northern part of the lake. That area is now Robert's Bird Sanctuary. Figure 8B shows a bathymetric map of Lake Harriet and Table 8A shows the morphometric data. Although a navigable channel between Harriet and Calhoun was proposed, only a pumping station and pipeline were constructed to connect the two lakes. The pumping station was later abandoned and flow from Calhoun to Harriet is now via gravity. Lake Harriet discharges to Minnehaha Creek over a fixed weir at the southern edge of the lake.

Brugam and Speziale (1983) analyzed deep sediment cores and determined that initial settlement in the 1850s by European-Americans had only a minor impact on water quality in Lake Harriet. As in Lake Calhoun, signs of accelerated eutrophication occurred in the 1920s after the connection of storm sewers to the lake. Surficial lake sediments (< 40 cm sediment depth) showed elevated amounts of phosphorus and organic material indicating increased sedimentation, likely due to land clearing and agriculture. Recent sediments also showed elevated phosphorous indicating increased lake productivity. In addition, fishery manipulations occurred throughout the 1900s likely affecting the trophic web structure of the lake.

Recent restoration techniques, or best management practices (BMPs), have improved water quality in Lake Harriet in recent years. A detailed Clean Water Partnership diagnostic study conducted in 1991 determined that phosphorus input to the Chain of Lakes should be reduced to improve water quality. BMPs were then implemented for Harriet and included: public education, increased street sweeping, and improved stormwater treatment (i.e. constructed wetlands (1998) and grit chambers (1994 - 1996)). A littoral (< 8 m) alum treatment was also used in 2001 to limit algal uptake of phosphorus and thereby limit growth and accumulation in shallower areas of the lake. Although not originally designed to do so, it has been shown that the alum had an unexpected benefit of limiting internal phosphorus loading in the lake (Huser, 2005). Current data analysis confirms that the BMPs are having a positive effect and that water quality in Lake Harriet is at, or even slightly better than historical, pre-impact conditions (Heiskary et al., 2004).

Figure 8A. Lake Harriet, looking north.

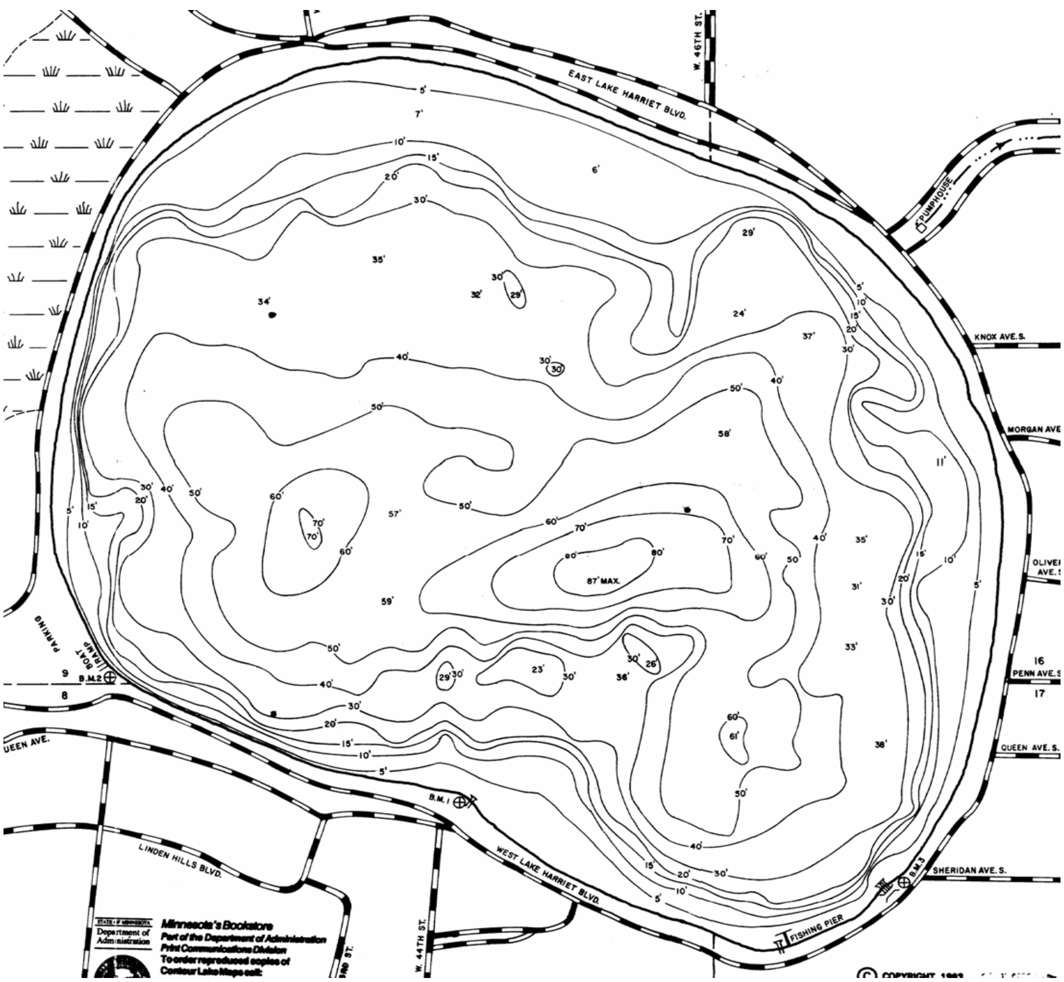


Figure 8B. Bathymetric map of Lake Harriet. Map courtesy of the Minnesota Department of Natural Resources (MDNR).

Table 8A. Lake Harriet morphometric data. * Littoral area defined as less than 15 feet deep.

Surface Area (acres)	Mean Depth (m)	Maximum Depth (m)	Littoral Area*	Volume (m^3)	Watershed Area (acres)	Watershed: Lake Area (ratio)	Residence Time (years)
353	8.7	25.0	25%	$1.25x10^7$	1,139	3.2	3.4

LAKE LEVEL

The lake level for Lake Harriet is recorded weekly. The historical lake levels for Lake Harriet are shown in Figure 8C for the entire period of record. Mean sea level elevation can be calculated by adding the city datum (710.3 feet) to the elevations shown in Figure 8C.

See Section 18 for a 2006 comparison between other MPRB lake levels.

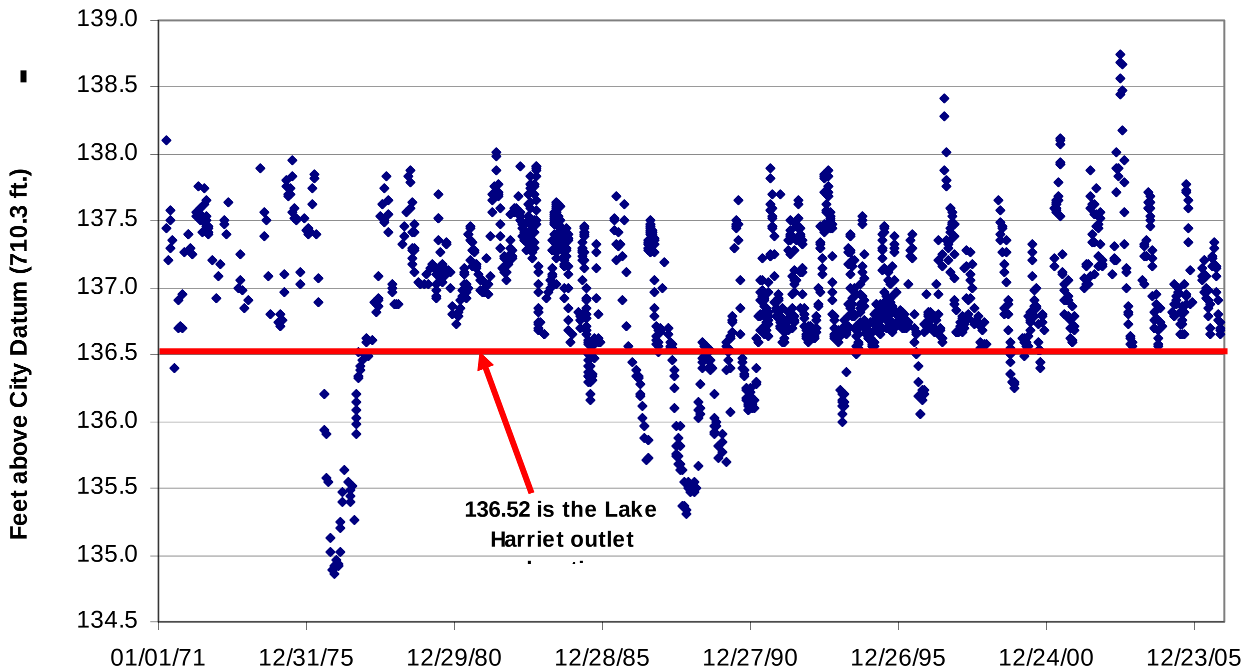


Figure 8C. Historical lake levels for Lake Harriet.

WATER QUALITY TRENDS (TSI)

The TSI scores for Lake Harriet are improving as shown by the linear regression in Figure 8E. A further detailed explanation of TSI can be found in Section 1. Figure 8E shows Lake Harriet TSI scores and trend lines.

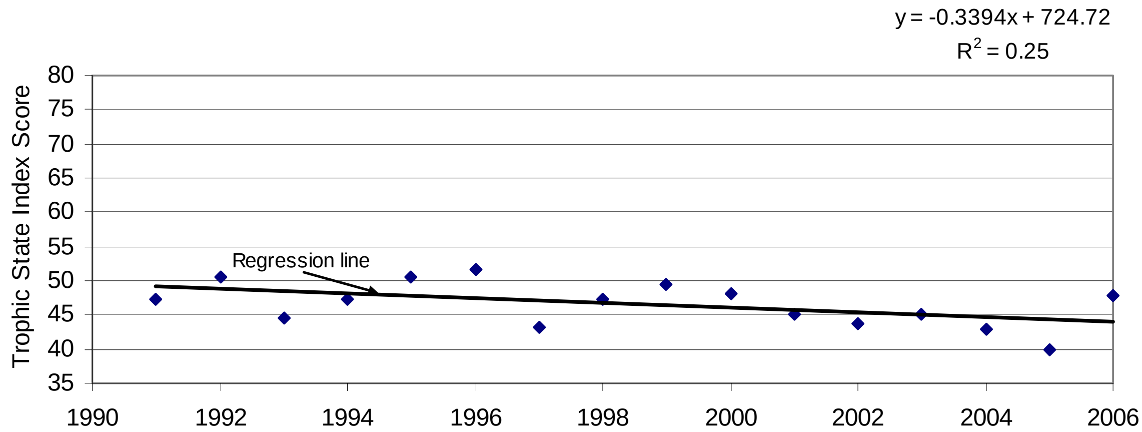
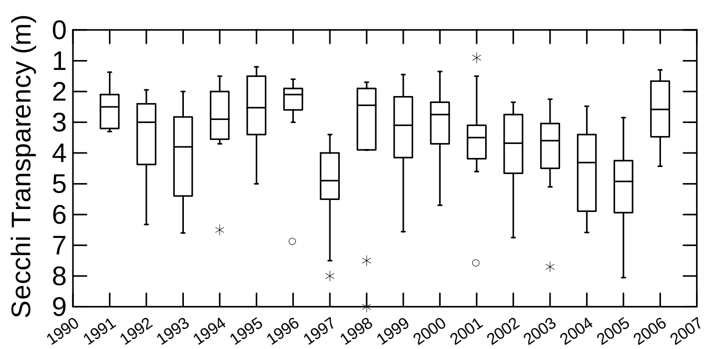


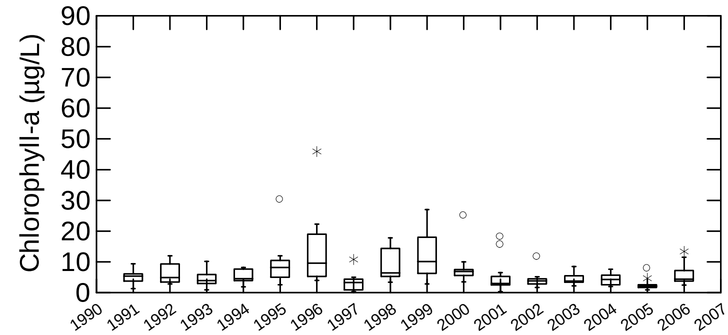
Figure 8E. Lake Harriet TSI scores and regression analysis.

Most of the Chain of Lakes, including Lake Harriet, are mesotrophic with moderately clear water and some algae. Lake Harriet has a trend towards decreasing TSI score and increased clarity, although 2006 was an unusually poor year for water clarity in Lake Harriet. Compared to other lakes in this ecoregion, Harriet is in the top 10% of TSI scores (based on calculations from the Minnesota Pollution Control Agency, using the Minnesota Lake Water Quality Data Base Summary, 2004). However, the median Secchi transparency by itself is in the top 5% for the ecoregion. Diatom reconstruction analyses suggest phosphorus concentrations peaked in the 1970s, due to large storm sewer system increases from previous decades. Recent research has concluded that phosphorus concentrations in Lake Harriet have been similar to those from pre-European settlement (Heiskary et al., 2004).

Box and Whisker Plots

The box and whisker plots show the scatter within the years data set for the Secchi, chlorophyll-*a* and total phosphorus in more detail. Long-term lake monitoring is necessary to evaluate the seasonal and year-to-year variations seen in each lake and predict trends. A further detailed explanation of box and whisker plots can be found in Section 1. Figure 8F shows the box and whisker plots of Lake Harriet TSI data.





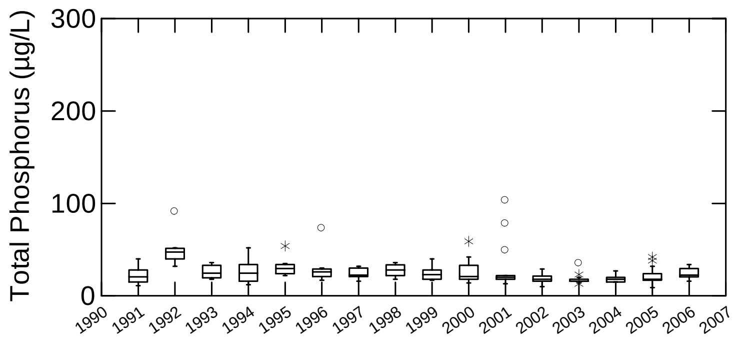


Figure 8F. Lake Harriet box and whisker plots of TSI data.

In 2006, the median Secchi transparency was worse than the previous several years. Average clarity was worse, and there were fewer outliers. The clear water phase in Lake Harriet was much less clear than in previous years, and on average, the clarity was about a meter worse during the majority of the season. Chlorophyll-*a* and phosphorus concentrations were higher in 2006 than in the previous five years, but were on average lower and had less scatter than the years prior to the alum treatment and BMP installations.

BEACH MONITORING

E. coli levels were sampled at two different locations on Lake Harriet, Harriet Main Beach and Harriet Southeast Beach. As can be seen from Table 8B, the season long geometric means for *E. coli* were very low. Both beaches were open for the entire season. Figure 8G illustrates the box and whisker plots of *E. coli* sampling results (per 100 mL) for Lake Harriet beaches for 2003 - 2006. The box and whisker plots show in more detail the scatter, within the years, of the data set. Further details on MPRB beach monitoring can be found in Section 19.

Table 8B. Summary of *E. coli* results (per 100 mL) for Lake Harriet beaches in 2006.

Statistical Calculation	Harriet Main	Harriet Southeast
Minimum Value	2	2
Maximum Value	42	152
Median Value	3	10
Geometric Mean	5	10
Standard Deviation	10	36
Number of Samples	41	41

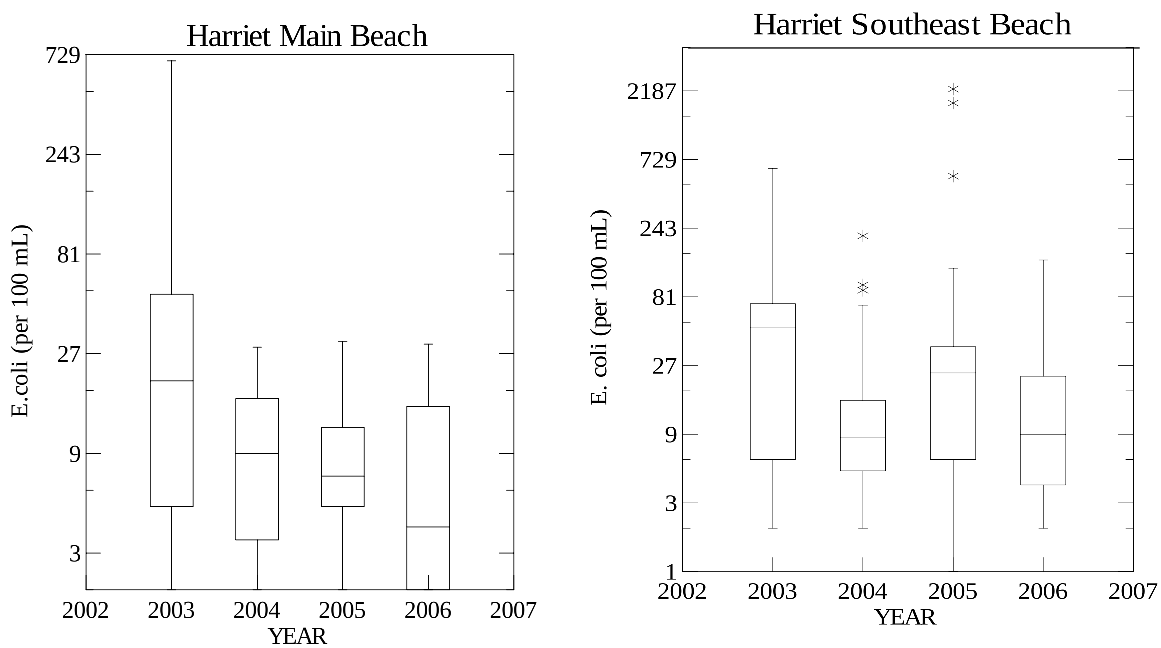


Figure 8G. Box and whisker plots of *E. coli* results (per 100 mL) for Lake Harriet beaches, 2003 to 2006. Note the log scale on the Y-axis.

Select correlations were observed for Lake Harriet beaches (Table 8C). Very strong positive correlations exist at Harriet Main Beach between *E. coli* and rainfall, rainfall duration, rainfall intensity, water temperature and air temperature and a very strong negative correlation existed with dissolved oxygen and percent dissolved oxygen. Harriet Southeast Beach had very strong positive correlations with rainfall, rainfall duration and intensity. Strong negative correlations existed with lake elevation, dissolved oxygen, percent dissolved oxygen, pH and specific conductivity.

Table 8C. Selected correlations (r) between *E. coli* (per 100 mL) and select variables at each beach on Lake Harriet in 2006.

Variables	Harriet Main	Harriet Southeast
Air Temperature	0.310	0.062
Dissolved Oxygen	-0.758	-0.494
Lake Elevation	-0.295	-0.578
Percent Dissolved Oxygen	-0.758	-0.445
pH	-0.195	-0.392
Rainfall	0.424	0.282
Rainfall Duration	0.371	0.821
Rainfall Intensity	0.393	0.970
Specific Conductivity	-0.130	-0.682
Water Temperature	0.358	0.090

Lake Aesthetic and User Recreation Index (LAURI)

Figure 8H shows the LAURI for Lake Harriet. Lake Harriet ranked "excellent" in aesthetics, water clarity and public health and "good" in aquatic plants. Details on the LAURI can be found in Section 1.

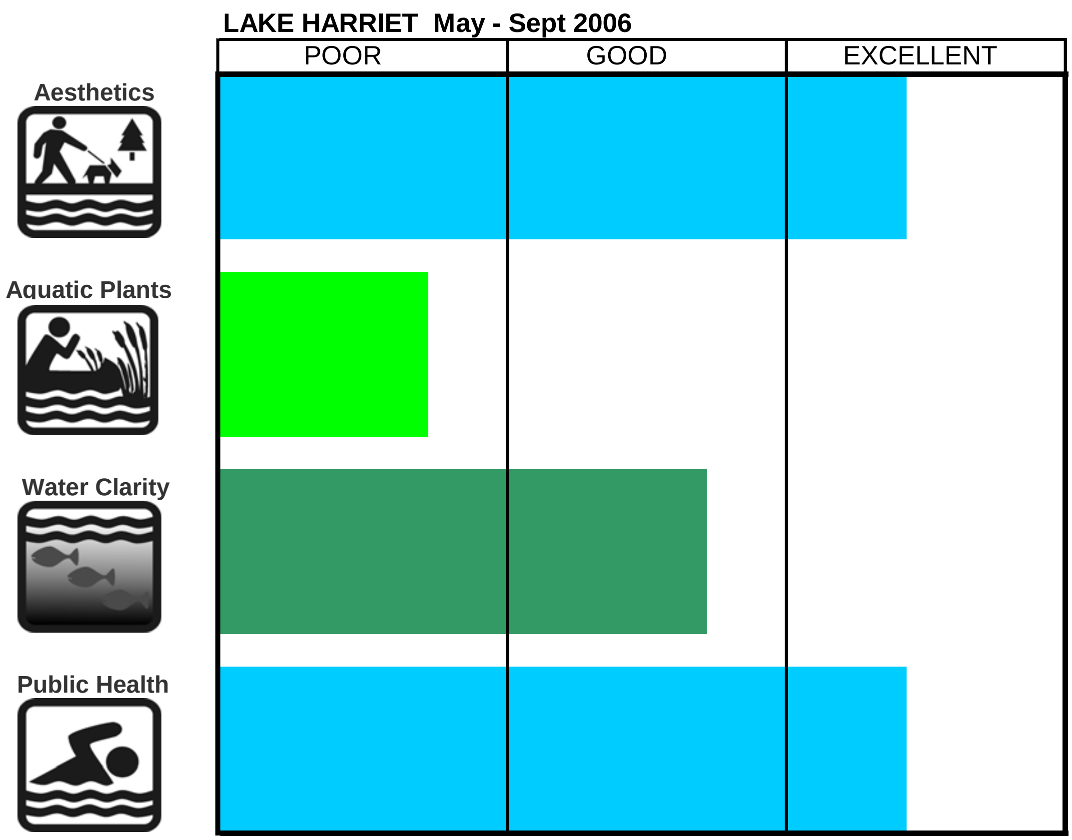


Figure 8H. The 2006 LAURI for Lake Harriet.

Winter Ice Cover

In the spring, ice came off Lake Harriet on April 7, 2006, which was one day earlier than the average. Ice came on to Lake Harriet on January 16, 2007 for the winter, which was about three weeks later than average. This was the latest ice on date ever recorded for Lake Harriet by over two weeks. See Section 1 for details on winter ice cover records and Section 18 for a comparison with other lakes.

Exotic Aquatic Plant Management

The MDNR requires a permit to remove or control Eurasian watermilfoil. These permits limit the area milfoil can be harvested from to protect fish habitat. The permits issued to the MPRB allowed for harvesting primarily in swimming areas, boat launches and in shallow areas where recreational access was necessary. The permitted area on Lake Harriet was 50 acres, which is 14% of the total lake area. More information on aquatic plants can be found in Section 1.

Phytoplankton and Zooplankton

Phytoplankton and zooplankton are the microscopic plants and animals that form the basic food web of lake ecology. The greenness of a lake is measured by chlorophyll-*a* (chl-*a*) as an expression of the phytoplankton present. Figures 8D and 8E show the relative abundance of phytoplankton, and chlorophyll-*a* concentrations during the 2006 sampling season. The percent (%) dominant are in reference to the total (division) community. Cyanophyta (blue-green algae) dominated through out the season, with cryptophyta (cryptomonads), chrysophyta (golden algae), and chlorophyta (green algae) more abundant in April with another increase in cryptophyta (cryptomonads) in fall. Peaks in chl-*a* were in April, July, and August (Figure 8E). Zooplankton concentrations were highest in the May samples, and arthropods were more abundant than rotifers (Figure 8L). Protozoans were only detectable in late summer to fall samples, and were less than 2% of the individuals sampled.

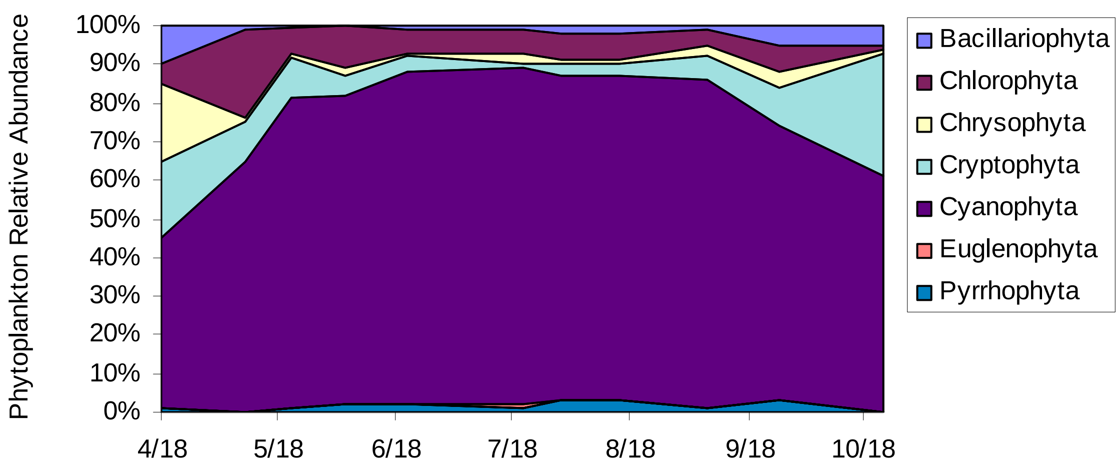


Figure 8D. Relative abundance of phytoplankton during the 2006 Lake Harriet sampling season.

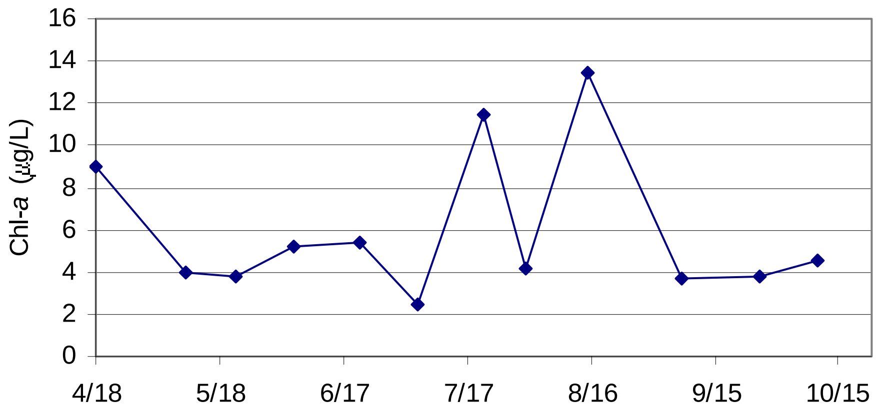


Figure 8E. Lake Harriet 2006 chlorophyll-*a* data.

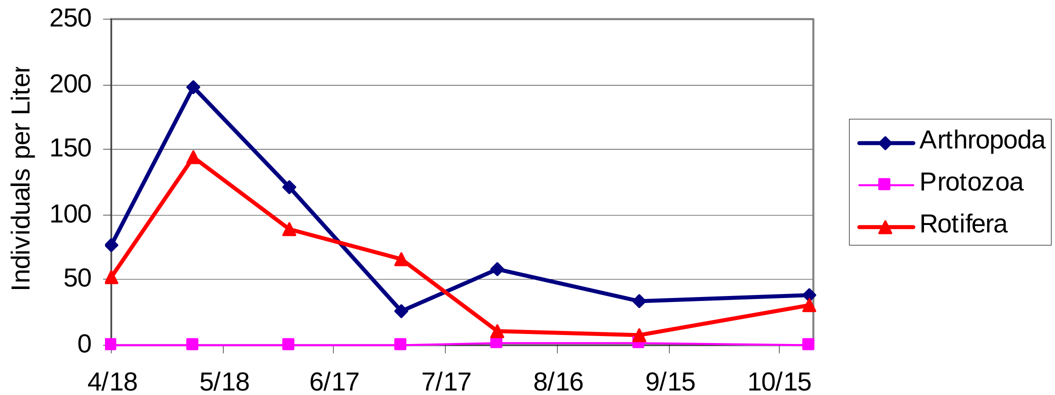


Figure 8F: Zooplankton distribution in Lake Harriet during the 2006 sampling season.

FISH STOCKING

Additional information and a definition of fry, fingerling, yearling and adult size fish can be found in Section 1.

Lake Harriet was stocked by MDNR in:
1998 with 250 fingerling Muskellunge, 1,365 fingerling Walleye
1999 with 824 fingerling Walleye, 50 yearling Walleye
2000 with 175 fingerling Muskellunge, 142 adult Walleye, 499 adult Walleye
2001 with 2,273 fingerling Walleye
2002 with 175 fingerling Muskellunge, 312 fingerling Walleye, 698 yearling Walleye
2003 with 554 fingerling Walleye, 33 yearling Walleye
2004 with 175 fingerling Muskellunge, 3,447 fingerling Walleye
2005 with 140 yearling Walleye
2006 with 175 fingerling Muskellunge, 1,919 fingerling Walleye, 33 adult Walleye