12 LAKE NOKOMIS

HISTORY

The Minneapolis Park and Recreation Board (MRPB) acquired Lake Nokomis, originally known as Lake Amelia, in 1907. Nokomis resembled a wetland then, with areas of open water, peat bog and wetland. Theodore Wirth (noted superintendent of MPRB) developed a plan that called for a reduction in surface water of 100 acres and an increase in parkland of the same amount. Dredging began in 1914 and nearly 2.5 million cubic yards of material was moved. Most of the spoils were used to create beaches, shoreline and parkways around the lake. Wirth correctly predicted that settling would occur by the newly created parkland and considerable restoration took place between 1934 and 1939 though the Works Progress Administration (WPA) program. The modifications made to Nokomis increased residential development in the area.

Figure 12A shows a lagoon of Lake Nokomis. Figure 12B is the current bathymetric map of Lake Nokomis and Table 12A contains the morphometric data.

Figure 12A. A lagoon in Lake Nokomis

Lake Nokomis is a shallow, polymictic lake that mixes multiple times during the growing season. Mixing potential is increased when higher than normal wind speeds occur along the fetch of the lake. This has the effect of destabilizing the water column and mixing hypolimnetic phosphorus into the surface water where it can be utilized by algae. In recent years, it has been hypothesized that mixing events have caused blooms of the cyanobacteria *Oscillatoria agardhii,* which gives the water a noticeable reddish brown appearance.

Numerous restoration projects have been implemented to improve water quality in the lake. Carp removal was conducted in the winter of 2001 and was designed to limit internal phosphorus loading caused by the fish foraging in the sediment. Increased street sweeping, grit chambers (2001) and wetland detention ponds (completed in 2001) were also implemented. An inflatable weir was installed in 2002 to prevent Minnehaha Creek water from entering the lake but was not operational until 2003. These best management practices (BMPs) seem to have improved the water quality of Nokomis in the two years following implementation.

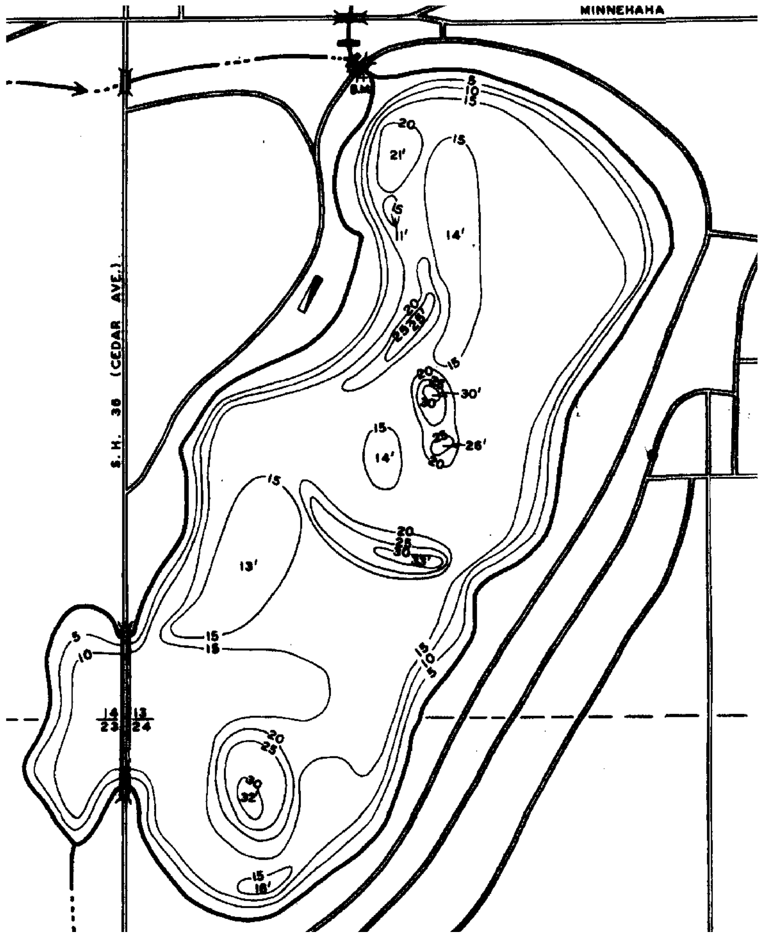


Figure 12B. Bathymetric map of Lake Nokomis. Map courtesy of the Minnesota Department of Natural Resources (MDNR).

Table 12A. Nokomis Lake morphometric data. * Littoral area was 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)
204	4.3	10.1	51%	$3.54x10^6$	869	4.3	4.0

LAKE LEVEL

Lake levels for Lake Nokomis are recorded weekly. In 2003, a staff gage was surveyed in at the Lake Nokomis outlet. The levels for 2003-2006 are shown in Figure 12C. Mean sea level elevation can be calculated by adding the city datum (710.3 feet) to the elevations shown in Figure 12C. See Section 18 for a comparison between other MPRB lake levels.

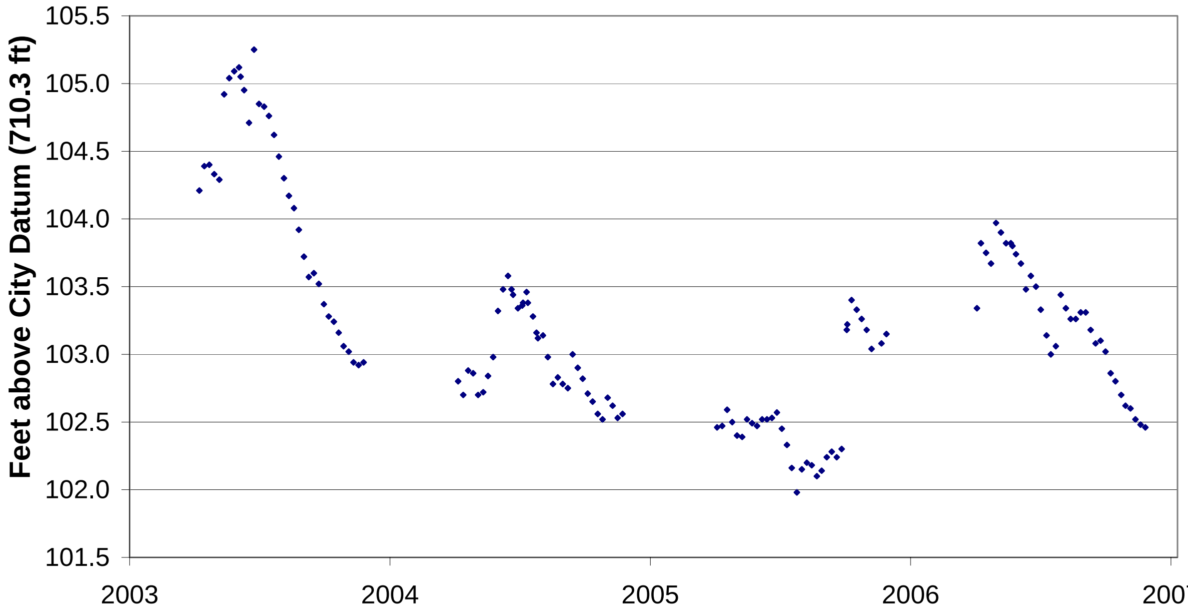


Figure 12C. Lake levels for Lake Nokomis, 2003-2006.

WATER QUALITY TRENDS (TSI)

Figure 12D shows the Lake Nokomis linear regression to be relatively flat as the TSI scores remain reasonably stable. A detailed explanation of TSI can be found in Section 1.

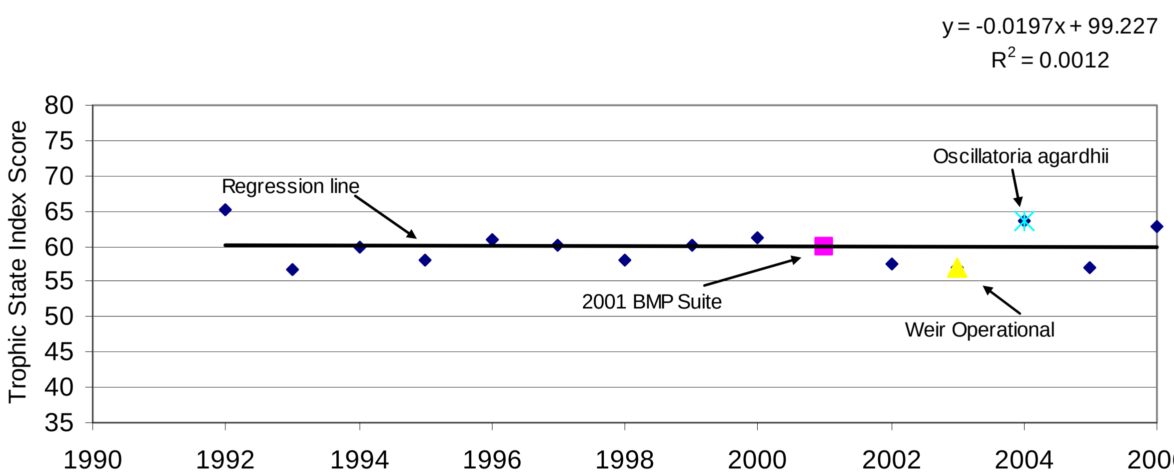


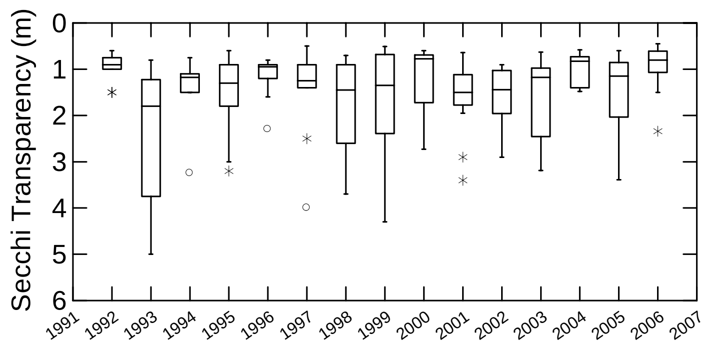
Figure 12D. Lake Nokomis TSI scores and regression analysis.

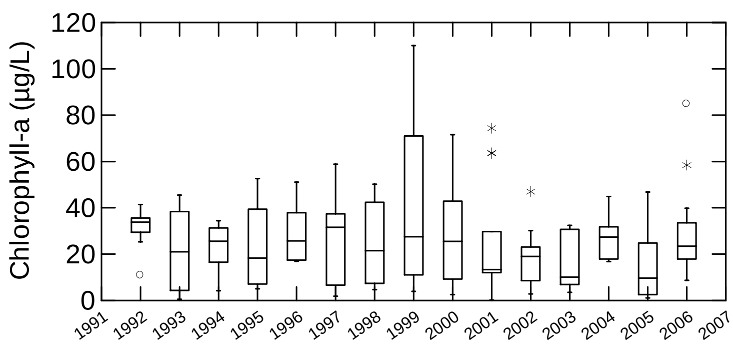
The 2004 TSI data point is likely due to wind mixing. The 2003 and 2004 wind data from the MPRB beach sampling program were compared. It was determined that 2004 had more fetch line winds which would lead to more turbulence and possible resuspension within the lake. Another explanation may be that *Oscillatoria agardhii* dominated the phytoplankton assemblage in 2004. Lake Nokomis is eutrophic with considerable amounts of algae, and blooms of algae limit light penetration and therefore Secchi depth. A third explanation may be a rebound effect from the carp removal in the winter of 2001. It has been hypothesized that several years after a removal, many small carp not caught during the removal process have reached the population size to have a negative effect on water quality. In the future, carp removals should ideally be planned for 3 consecutive years.

Nokomis has a TSI score that is below average for this ecoregion. It falls between the 50th and bottom 25th percentile category for lakes in this ecoregion (based on calculations from the Minnesota Pollution Control Agency, using the Minnesota Lake Water Quality Data Base Summary, 2004).

BOX AND WHISKER PLOTS

The box and whisker plots show in more detail the scatter within the years data set for the Secchi, chlorophyll-*a* and total phosphorus. Long-term lake monitoring is necessary to evaluate the seasonal and year-to-year variations seen in each lake and predict trends. A detailed explanation of box and whisker plots can be found in Section 1. Figure 12E shows the box and whisker plots of TSI data. The spread in the Lake Nokomis data may be due to the polymictic nature of the lake, years with more mixing events and less stable stratification can result in greater phosphorus return from the sediments and more algal productivity near the surface. The last three years of data, since the weir separating the lake from Minnehaha Creek has been in operation, may represent a new normal for Lake Nokomis.





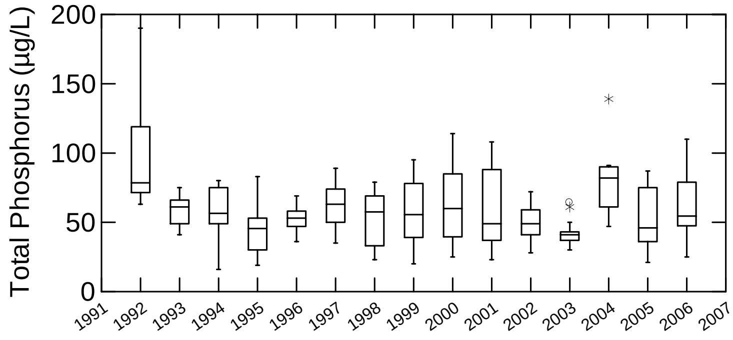


Figure 12E. Box and whisker plots of Lake Nokomis TSI data.

Beach Monitoring

Bacteria levels were monitored at two different beaches on Lake Nokomis in 2006, Nokomis Main Beach and Nokomis 50th Street Beach. As can be seen from Table 12B, the season long geometric mean for *E. coli* for both beaches was extremely low. Nokomis 50th Street Beach had one of the lowest season long geometric means of all MPRB beaches and Nokomis Main Beach was among some of the lowest values. Both beaches also had some of the lowest median values of *E. coli* of all the MPRB beaches. Nokomis Main and Nokomis 50th Street beaches were open for the entire season. Figure 12F illustrates the box and whisker plots of *E. coli* sampling results (per 100 mL) for 2003 to 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 12B. Summary of *E. coli* results (per 100 mL) for Lake Nokomis beaches in 2006.

Statistical Calculation	Nokomis Main	Nokomis 50th
Minimum Value	2	2
Maximum Value	94	66
Median Value	7	3
Geometric Mean	8	6
Standard Deviation	21	15
Number of Samples Taken	42	41

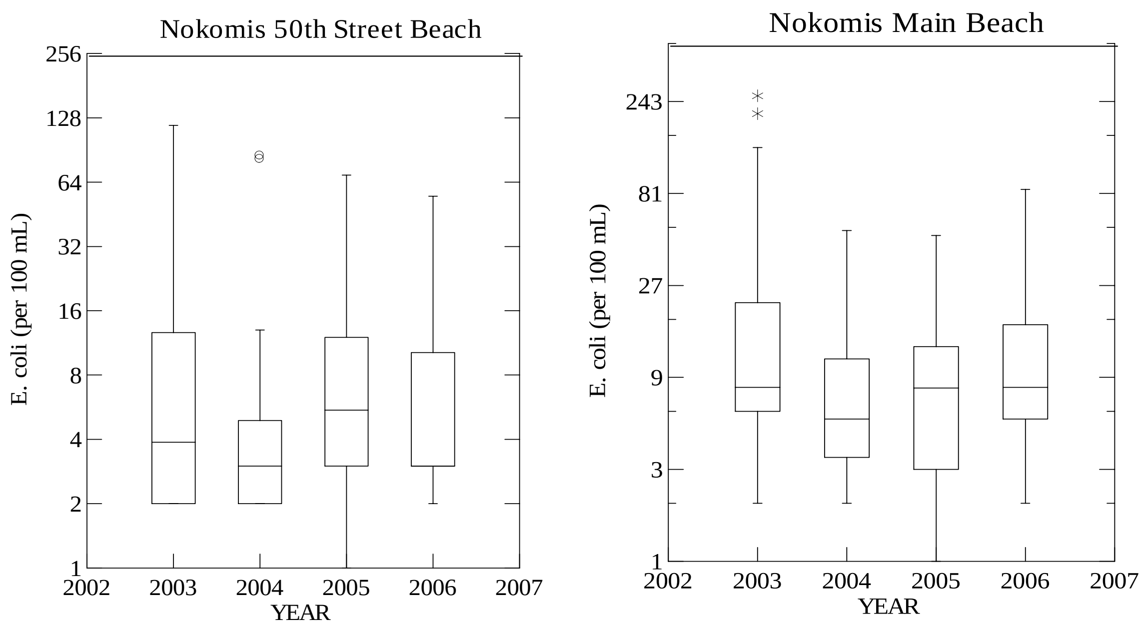


Figure 12F. Box and whisker plots of Nokomis Main Beach and Nokomis 50th Street Beach *E. coli* results (per 100 mL), 2003 – 2006. Note the log scale on the Y-axis.

Table 12C gives select parameters that correlated with *E. coli* at Lake Nokomis beaches. Rainfall, rainfall duration and intensity had very strong positive correlations at both Nokomis Main and Nokomis 50th Street Beaches. At Nokomis Main Beach there were very strong negative correlations with dissolved oxygen, percent dissolved oxygen, and pH. Nokomis 50th Street Beach also had strong negative correlations with dissolved oxygen, percent dissolved oxygen, pH, and specific conductivity.

Table 12C. Selected correlations (r) between *E. coli* (per 100 mL) and select variables at Lake Nokomis beaches in 2006.

Variables	Nokomis 50th	Nokomis Main
Dissolved Oxygen	-0.779	-0.85
Percent Dissolved Oxygen	-0.709	-0.816
pH	-0.584	-0.447
Rainfall	0.664	0.835
Rainfall Duration	0.708	0.907
Rainfall Intensity	0.906	0.830
Specific Conductivity	-0.534	-0.287

Lake Aesthetic and User Recreation Index (LAURI)

Figure 12G shows that Lake Nokomis scored “excellent” in aesthetics, aquatic plants, and swimming (public health). Water clarity scored “poor”. Large amounts of algae limit water clarity which causes less light to penetrate the water column. This restricts the growth of aquatic plants leading to an “excellent” rating for aquatic plant interference.

Figure 12G. The 2006 LAURI for Lake Nokomis.

WINTER ICE COVER

Ice came off Lake Nokomis on April 6, 2006, which is just two days later than average. Ice came on to the lake for the winter on December 5, 2006, a week later than average. 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 from which milfoil can be harvested 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 Nokomis was 25 acres, which is 12% of the total lake surface area. Lake Nokomis was harvested for Eurasian watermilfoil in mid-July during the 2006 season due to a national triathlon event. See Section 1 for details on aquatic plants.

PHYTOPLANKTON AND ZOOPLANKTON

Phytoplankton and zooplankton are the microscopic plant and animal life 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 12H and 12I show the phytoplankton and chl-*a* data. During the 2006 sampling season cyanophyta (blue-green algae) comprised at least 50% of the samples for every sampling period. Most samples were at least 80% cyanophyta. Chrysophyta (golden algae) made up approximately 20% of the community during a short period in late May, and correlated to the lowest chl-*a* reading of the season. Chl-*a* concentration peaked in mid-August when cyanophyta was dominant.

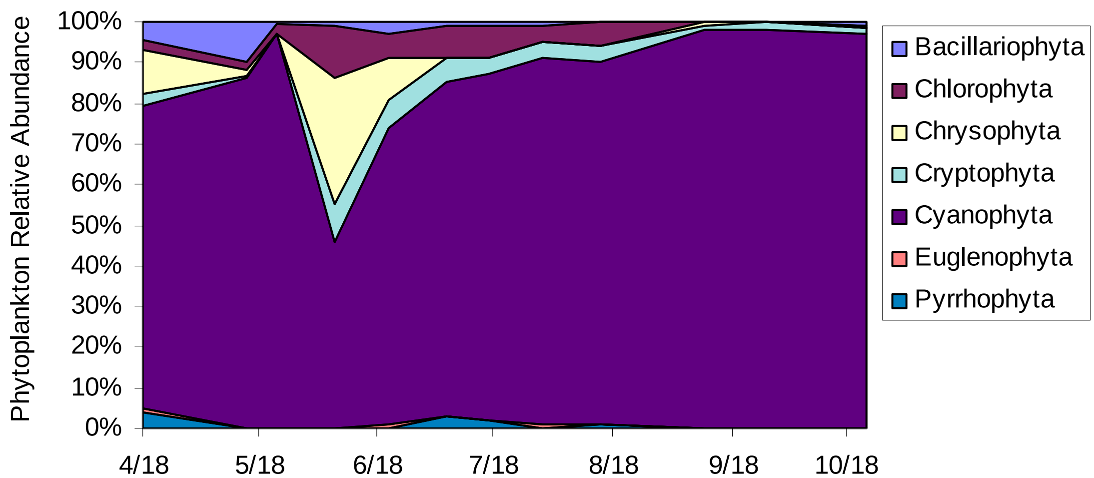


Figure 12H. Lake Nokomis relative abundance of phytoplankton divisions during the 2006 sampling season

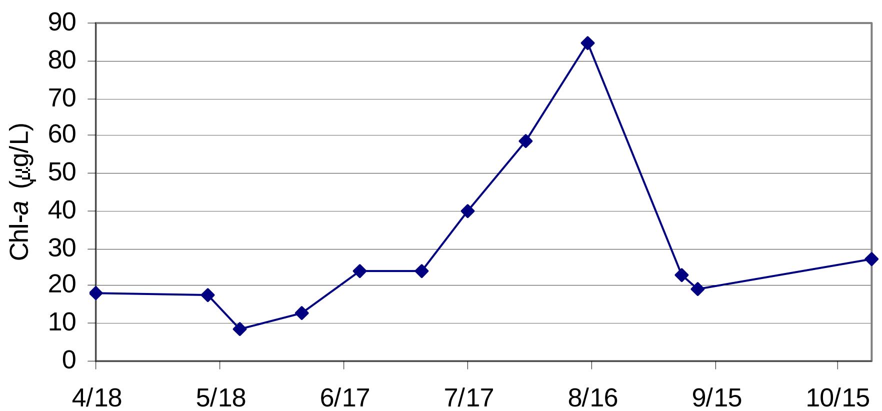


Figure 12I. Lake Nokomis 2006 chlorophyll-*a* data.

Lake Nokomis is prone to periodic large blooms of blue-green algae (cyanophyta). In the spring of 2004, Lake Nokomis water appeared turbid and brownish colored. It was determined a blue-green algae (cyanophyta) species, *Oscillatoria agardhii,* was mainly responsible for the bloom. The primary pigment of this algal species is phycoerythrin which is purple to brown in color, instead of chlorophyll-*a,* which is green. Figure 12J shows the comparative distribution of *Oscillatoria agardhii* in Lake Nokomis in 2003, 2004, and 2006. Another brown *Oscillatoria agardhii* bloom occurred in the spring of 2006.

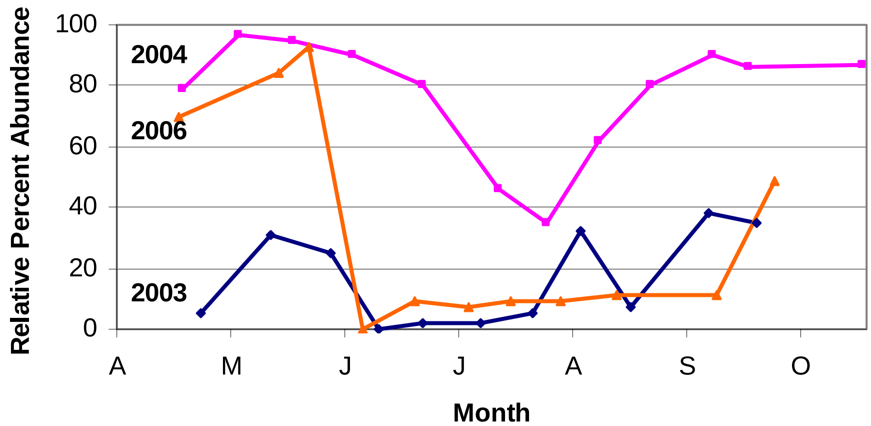


Figure 12J. Percent abundance of the cyanobacteria species *Oscillatoria agardhii* during the 2003, 2004, and 2006 sampling seasons. 2005 data was not used due to limited samples. Blooms of this species result in brown turbid water in Lake Nokomis.

Zooplankton distribution in Lake Nokomis is shown in Figure 12K. Similar to other lakes in the system, a May zooplankton peak corresponded to the lowest levels of measured chl-*a* concentrations for the season. Unlike other lakes in the system, higher numbers of zooplankton were found later in the season. Rotifers peaked a second time at a higher concentration in July-August, and arthropods reached greater numbers in September-October. Protozoans occurred at levels that were below the detection limit for the sampling method.

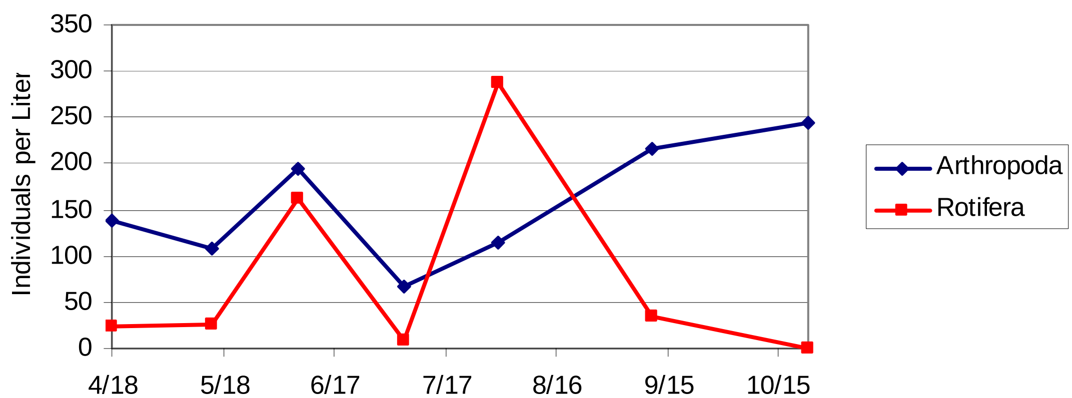


Figure 12K. Zooplankton distribution in 2006 in Lake Nokomis.

FISH STOCKING

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

Lake Nokomis was stocked by the MDNR in:
1998 with 400 fingerling Tiger Muskellunge
1999 with 82,144 fry Tiger Muskellunge, 773 fingerling Walleye, 46 yearling Walleye
2000 with 300 fingerling Tiger Muskellunge
2001 with 8,065 fingerling Walleye
2002 with 300 fingerling Tiger Muskellunge
2003 with 7,873 fingerling Walleye
2005 with 4,266 fingerling Walleye
2006 with 300 fingerling Tiger Muskellunge